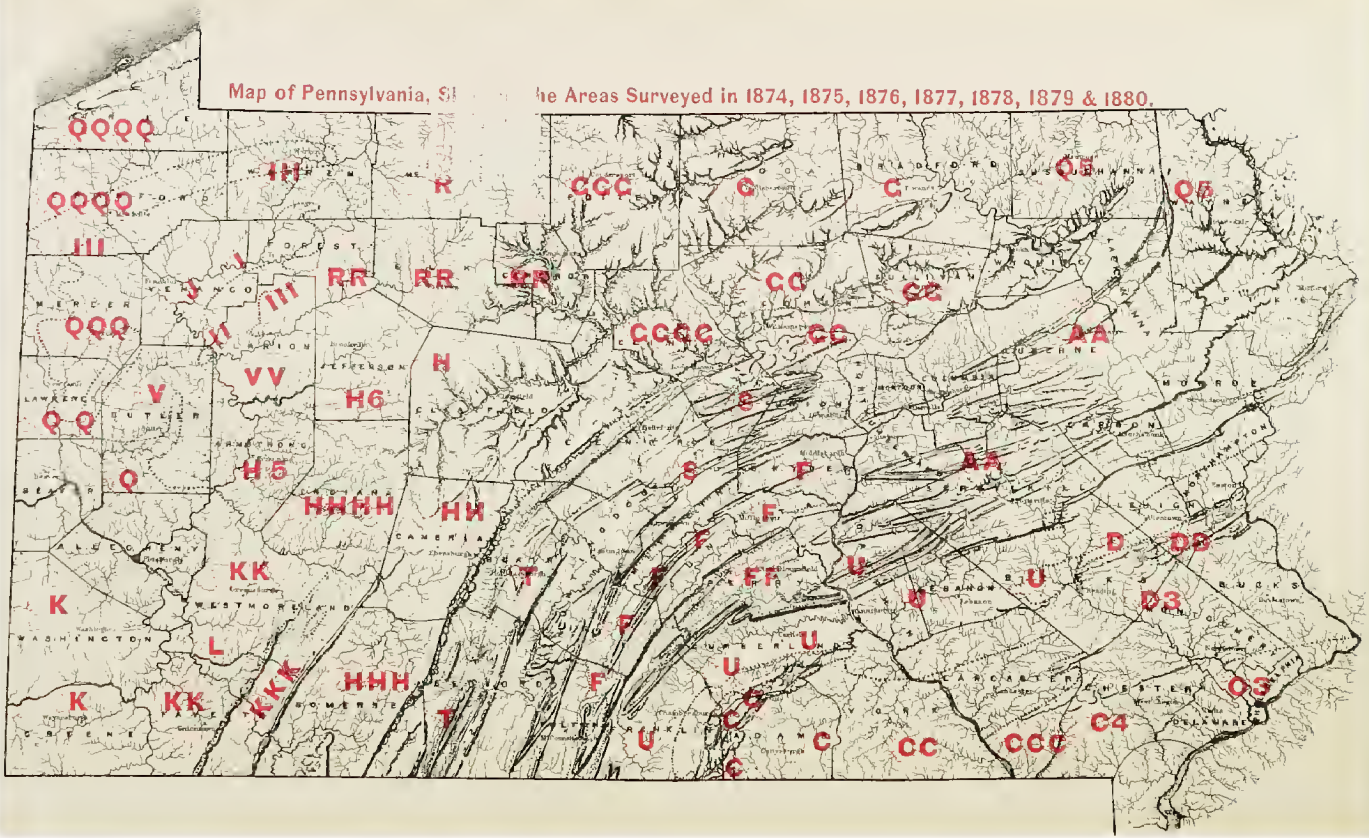
Map of Pennsylvania, Sh he Areas Surveyed in 1874, 1875, 1876, 1877, 1878, 1879 & 1880.
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SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA,

JANUARY, 1881.

A

SPECIAL REPORT

TO THE LEGISLATURE

UPON THE

CAUSES, KINDS AND AMOUNT OF WASTE

IN

MINING ANTHRACITE.

By FRANKLIN PLATT.

WITH A CHAPTER ON THE METHODS OF MINING.

By JOHN PRICE WETHERILL.

ILLUSTRATED BY 35 FIGURES OF MINING OPERATIONS;
A PLAN OF AN ANTHRACITE BREAKER;
AND
A SPECIMEN SHEET OF THE WORK OF THE GEOLOGICAL SURVEY IN THE ANTHRACITE COAL FIELDS.

HARRISBURG:
PUBLISHED BY THE BOARD OF COMMISSIONERS
FOR THE SECOND GEOLOGICAL SURVEY.
1881.

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By WILLIAM A. INGHAM,

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PREFACE.

At its last session the Legislature passed the following Joint Resolution:

Be it resolved, (*the Senate concurring*,) That the Board of Commissioners of the Geological Survey of the State be requested to cause a Survey and Examination of the Anthracite Coal Region to be made, paying special attention to the question of the rapid exhaustion of this most valuable deposit, more economy in the methods of mining, and the avoidance of the great waste and over production now threatening ruin to all interested in the trade, and to make a special report with reference to these subjects, and suggesting if possible a remedy for the evils above recited.

One of the subjects referred to the Board of Commissioners, that of over production, has been happily solved by the agreement of all the parties interested to restrict production to the wants of the consumers. Others of these subjects, such as the rapid exhaustion of the coal, and greater economy in the methods of mining can only be answered after a careful and exhaustive survey which is now in progress, and which only requires a continuance of the appropriation to be completed as rapidly as can be done with due regard to accuracy. The subject of the Waste in Mining and in the subsequent handling of the coal is answered by the Report herewith submitted. The result though long known to thoughtful and observant Mining Engineers is sufficiently appalling when now for the first time laid before the public with the details on which the calculations are based. That not over one third of the coal lying in the ground can ever be brought to market, at least by our present methods of extraction and manipulation must seriously impair confidence in the soundness of those methods, and in

the ultimate value of this peculiar inheritance of Pennsylvania. It is to be hoped that the progress of Engineering science and skill will do much to diminish if not entirely remove this source of loss.

Accompanying this Report will be found an Underground Contour Line Map of a portion of the Schuylkill Coal Fields in the vicinity of Mahanoy City. This Map has been prepared by Mr. Chas. A. Ashburner, who is now engaged on a branch of the Anthracite Survey which has special reference to the exhaustion of the coal. It is submitted herewith as a specimen of the plan adopted for the work, and as an illustration of the large amount of information which can be placed upon a Map without confusion or overcrowding.

With this Preface the Report on Anthracite Waste is respectfully submitted to the Legislature.

By order of the Board.

WM. A. INGHAM,
Secretary.

615 WALNUT STREET,
PHILADELPHIA, *December 31, 1880.*

Prof. J. P. LESLEY, *State Geologist:*

DEAR SIR: About May 1, 1880, I received your instructions to prepare a report upon the wastage in mining and preparing anthracite coal; and also a notification that the report must be presented in time to allow of its being printed and published by January 1, 1881.

While the time allowed for this work was insufficient to permit much original investigation, it was possible to gather some information on these questions, and to apply this information to records of breaker waste kept by some companies for periods previous to May 1. This has been done in every case where such records were accessible.

The report explains sufficiently in its wastage chapters why a long continued and careful record at many breakers is needed for correct averages of waste.

Such records must embrace the different varieties of anthracite from the soft coal of the Lykens Valley bed to the hard and tough coal of the Mammoth bed at Hazleton; the differing character of coal shipped, whether of large or small sizes; the steep or flat dip of the coal bed; and the character of the roof and slate partings; the size and purity of the coal bed; and the physical structure of the coal, by which it shatters more or less in the breaker.

To properly answer such fully stated questions this wastage examination must be continued, using as a basis this preliminary report.

As the report is intended to be used by many persons who are entirely unfamiliar with the method of deposit of anthracite coal, as well as of the methods of mining and preparing it for market, three preliminary chapters are given before treating of the statistics of wastage.

The first chapter shows how anthracite coal lies in basins,

its method of deposit requiring it to be worked at varying angles of dip, from vertical to horizontal, and indeed changing in the same colliery; the proportion that the beds of coal bear to each other in thickness, and to the thickness of the rocks separating them; and the slate layers which overlie them, and which are also interleaved in the coal mass, separating a single coal bed into many benches of coal and slate. This chapter is illustrated by a cross section and vertical section.

The second chapter shows how anthracite coal is mined. This chapter is copiously illustrated, the subject being one which requires much illustration to bring it home to one entirely unfamiliar therewith. The entire chapter and the accompanying plates were furnished by J. Price Wetherill, Associate Engineer of the Philadelphia and Reading Coal and Iron Company.

The third chapter shows how anthracite coal is prepared. A plate shows the construction of the breaker. This also is from Mr. Wetherill, having been made by him some years ago to illustrate a report of the Girard coal properties. It serves to show just what becomes of the load of coal and slate brought out in the mine car.

Having prepared the way to a proper understanding of processes and terms, the remaining chapters are devoted to the statistics of wastage at various stages from the time when the coal is first struck in the mine to the delivery of the prepared coal in cars for shipment to market.

Such an examination as this could not be carried on without the active aid of many persons whose positions as mining engineers or as coal operators enable them to afford means of securing exact figures concerning waste in mining and preparing.

The Survey is under special obligations to Mr. S. B. Whiting, Chief Engineer, and Mr. J. P. Wetherill, Associate Engineer of the P. & R. Coal and Iron Co.; Mr. Israel W. Morris and Fred. Mercur, of the Lehigh Valley Coal Company; Mr. Jos. S. Harris, of the Lehigh and Wilkes-Barre Coal Company; Col. Brown, of the Philadelphia Coal Co.; the Messrs. Riley, Mining Engineers of Ashland; Mr.

E. B. Coxe, of Drifton ; Mr. Jones, Mine Inspector ; Messrs. Thos. McNair and Calvin Pardee, of Hazelton ; Mr. Snyder, of the D. L. & W. RR., and many others.

I remain,

Your ob't serv't,

FRANKLIN PLATT.

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Chapter I.

How Anthracite Coal lies in the rocks.

The Anthracite coal fields of Pennsylvania occupy parts of the counties of Northumberland, Schuylkill, Carbon, Luzerne, and Lackawanna.

They are in four great subdivisions.

1. The First Great basin, including in this the whole basin from the Lehigh river to the Susquehanna river, passing through Tamaqua, Pottsville and on west to the extreme west end of the Lykens Valley and Dauphin fields.

2. The Second Great basin, through Mahanoy and Ashland, westward to Shamokin and Trevorton.

3. The Lehigh Coal fields including the Hazleton, Jeddo, Black creek, Buck Mountain, &c., basins.

4. The Wyoming-Lackawanna basin, from Nanticoke to Carbondale, being included in one great basin.

This quadruple subdivision will answer for general illustration, neglecting in the statement the numerous anticlinal and synclinal axes which subdivide these great basins into numerous small basins.

In addition to these fields named there is a small outlying basin on McCauley's mountain, and also a small basin of semi-anthracite coal on the Loyalsock creek in Sullivan county. These however are very small and need not enter into the present computations or report.

The total area of the four anthracite fields is only about 480 square miles.

The reader will find appended to this report two cross sections of basins of the anthracite fields, and also a vertical section of the measures.

The vertical section shows the number and order of the coal beds; how far they are separated from each other; the character of the separating rocks which lie between the coals; the size of the coal beds as compared to one another and also the total thickness of all the coal beds as compared with the total thickness of the rocks in which they lie.

In chapter IV and in chapter V there are some sections which show how the actual coal bed itself is constituted.

It is very rarely that a coal bed consists of pure coal from the roof to the floor. Usually there are seams and layers of interleaved slate or bone coal, as these sections show; and there are numerous places where one or more of the subdivisions of coal, called benches, will be impure or "shelly" coal, or will run into a seam of worthless coal dirt.

In the Mammoth bed of the Mahanoy region the thickness of the coal is very great, running up to 60 feet, and in places the bone and slate are from 25 to 30 per cent. of the total thickness of the bed.

It is not intended here to go into the figures of bone and slate in the different coal beds, but to call attention to the fact that the percentage of bone and slate, shelly coal and dirt, all included under the head of refuse, varies not only in all the different coal beds, but varies in the same coal bed in different parts even of the same mine. In fact that such constant variation is the natural condition of the deposit and is to be always looked for.

This in an important factor in the wastage question, for coal is lost by sticking to the bone and slate; and the handling of this refuse adds materially to the cost of mining.

The cross sections show how the coal beds lie in the ground, in basin shape, interstratified with the sandstones, slates and shales which make up the coal measure rocks.

It is important that this matter should be clearly compre-

hended in order that the reader may understand why the coal must be mined on the varying degrees of dip; by shaft or slope; below water level or above it.

A study of the cross section shows this more clearly than words can describe it. The coal beds dipping in from the edge or rim of the basin plunge downward on a steep slope, flatten off to horizontality, roll over and over again, sometimes overturning on themselves and then rise out to daylight finally on the opposite side of the basin. In these various close folds it is not a matter of surprise that there is much worthless crushed coal in the seam, but that the amount of crushed coal is not very much greater.

In some parts of the anthracite coal fields only the lower coal beds remain, those originally lying above having been swept away. In other parts the coal basins are very deep, and the coal at the center of the basin will be worked from deep shafts, all of the coal beds being present, from the lowest to the uppermost coal beds of the vertical section.

The coal beds differ somewhat from each other in appearance, fracture, physical structure, chemical composition and hardness; and these differences determine the uses to which they are to be put, these uses ranging from the blast furnace or steamboat boiler down to house fuel. And this use determines a considerable part of the wastage; for while the large sizes have little breaker loss, the coal which is for domestic use in small sizes makes a heavy percentage of loss in breaking, screening and loading before it reaches the market.

But while the coal beds of the Pennsylvania Anthracite basins differ somewhat from each other, yet they are all anthracite coal, or rather they vary from hard anthracite to semi-anthracite. This is the utmost range of variation in any of the four great basins already named.

In Sullivan county, Pennsylvania, there is a developed semi-anthracite coal bed, and 60 feet below it a semi-bituminous coal bed; and in one case these varieties of coal are only 6 feet apart. In Wales also the different varieties of coal, from anthracite onward through semi-bituminous to bituminous coal are found in the same coal field.

But in the Pennsylvania anthracite of the four great basins all the coal found so far is anthracite.

Directly connected with the question of wastage comes the amount of coal that remains for us to waste.

Various estimates, and widely different ones, have been made of the total amount of coal in the ground and what proportion thereof would reach market.

This volume is devoted to the question of what is the wastage in mining and preparing coal. The next volume will continue the subject of wastage and at the same time deal with modifications and improvements in the present systems, as well as enter into the calculations of total yield and total loss.

By John Price Wetherill.

Chapter II.

How Anthracite Coal is Mined.

The coal beds of the anthracite formation are over 30 in number, and vary in thickness from less than one inch up to 100 feet; they occur at all angles of inclination, but are seldom flat for any great extent. They contain, in various proportions, coal, slate, "bone," composed of alternating laminæ of coal and slate, and an unsolidified coal called dirt, (see sections of Fig. 20,) a uniform seam of coal alone being rare. The thickness of the same seam is not constant over any extended area, and may vary greatly in quite short distances; the sections of Fig. 20 are all from the same seam in different localities of the Middle and Southern Coal Fields.

The upper walls are conglomerate, sandstone, or slate, the first two hard and solid in texture, and withstanding the action of the atmosphere and moisture of the mine sufficiently well to give but little trouble in the mining operations, while the latter crumbles rapidly on exposure, owing, in part, to the decomposition of iron pyrites, which it contains in large quantities, and, in part, to its own friable character, and requires constant care to avoid accidents to the men working below it, as well as to prevent its mixing with the coal mined. The floors are slate.

Seams less than 3½ to 4 feet thick are not now considered workable, but, without doubt, those as small as 15 inches will be worked here to a profit, as they are in other countries, after the larger ones have been so nearly exhausted as to make coal higher in price.

As in all mining operations, the general system pursued is to reach, with a permanent outlet, such a point in the

* An outline of anthracite coal mining; by J. Price Wetherill; a paper read before the American Institute of Mining Engineers, at the October meeting of 1876, in Philadelphia; rewritten by the author for this report.

seam as will insure an amount of coal above the level of that point that will be profitable to work, and all the winning operations are carried on in that coal. By this means a natural drainage for the water is secured, and advantage is taken of the inclination of the seams to cause the coal to move by its own gravity wherever possible. The amount of coal that can be profitably worked is usually considered about 100 yards on the pitch of the seam, and not less than three fourths of a mile on the strike of the seam; this is called one "lift." In some cases it is advantageous to develop more than one lift with the outlet. Where two lifts are desired, the distance will be two hundred yards on the dip; where three, 300 yards, etc.

The outlets are those passages by means of which access is obtained to the point in the seam at which it is desired to begin mining operations; they may be of four kinds:

1. The drift, which is a gallery or gangway driven from day in the seam, in the direction of the strike, and is only possible where ravines or gaps have cut mountain ranges containing coal strata. As the mining operations generally begin as soon as the drift has been driven into the solid measures, and as coal is the softest of all the strata in the formation, this is the cheapest method of developing a colliery. Another economy is in the fact that no pumping or hoisting machinery is required.

2. The tunnel, which is driven from day, at right angles to the strike of the measures, until the seam desired is reached.

Owing to the small cost at which a mine may generally be opened by either of these, most of the localities favorable for their adoption were among the first developed, so that it is now almost always necessary to open a colliery by means of the following:

3. The slope, which is sunk in the seam in the direction of the dip; the coal is hoisted through it, by machinery, to day.

4. The shaft, which is sunk vertically through the measures until the seam desired is reached.

When the point desired is reached by the tunnel, or slope,

or shaft, two gangways are driven, one on each side, in the seam, and in the direction of the strike, as nearly level as will admit of the water draining readily to the outlet, where it is conveyed by suitable appliances to day. The usual grade is 4 to 6 inches in 100 feet.

The gangways are driven night and day continuously, and all the coal mined for 100 yards above them passes through them to the outlet.

Figs. 1, 2, 3, 4, 5, and 6 show the different sizes and form of timbering most generally in use in the Schuylkill region. Railroads are laid in them with T iron rails, 25 to 35 lbs. to the yard—the gauge varying from 36 to 48 inches, with the size of the seam and gangway.

The coal is loaded in the mine into mine cars, called "wagons," which run on the roads and contain from 75 to 120 cubic feet. They are of almost endless variety in size, form, and construction.

Locomotives are preferred as the motive power in gangways, but as the exhaust-steam and gases produced by the furnace very seriously vitiate the air and complicate the ventilation, and there is great danger that the fire may cause explosions in mines producing fire-damp, their use is at present restricted to a few collieries possessing advantages in ventilation, and the motive-power is generally supplied by mules. I am not aware of any instance of the use of the moving ropes or chains used in England for that purpose, or of any case in which the plan has been tested with us. As soon as the gangways have reached points where mining operations can be begun without endangering the stability of the outlet, the first breasts are started. They are excavations, or chambers in which the coal is mined, driven of a uniform width, at right angles to the strike, or directly up the pitch for 80 to 90 yards. A pillar of solid coal is left on each side of every breast, and running its entire length, to give solidity to the work, and prevent a general crushing down of the top. The breasts are turned as fast as room is made for them on the gangway, and when the first is finished the men are moved forward to a new one.

This is the ordinary breast and pillar or post and stall

method of working, which was found to be undesirable abroad and abandoned in many localities for methods securing a greater saving of coal.

Figs. 7 and 8 show the arrangement of breasts, being a sectional view and plan on the plane of the seam.

The shaded portions indicate those from which the coal has been removed. B is the breast, P the pillar, A is a solid block of coal, called a "stump," left to sustain the great weight that would come on the gangway timbers if the breast were opened the full width from the gangway; the two small openings *aa'* answering every purpose as passages for the coal mined above to the wagon on the gangway, and for the men to get to and from the breast. They are called shutes, and are driven 4 feet high, 4 to 6 feet wide, timbered with 6-inch timber, and are given, where possible, an inclination that will permit the coal to descend by its own gravity to the wagons on the gangway. They are provided with a projecting apron that reaches out over the wagon, and a gate by which the coal can be held back until it is required.

In steep-pitching seams the coal mined at the face of the breast falls to the shute, and through it into the wagon by its own weight, is hauled to the outlet, and thence to day, and is never handled at all in the process of mining. The headings marked *c* are small passages 4 to 6 feet wide, 6 feet high, driven continuously like the gangways, and used for purposes of ventilation; the dotted line across each breast shows its upper side previous to the removal of the coal and the opening of the breast. The breast-headings *d* are also used for ventilation alone.

Figs. 9, 10, and 11 show the details of a shute and breast. A is the stump and P the pillar. The floor is laid with two-inch plank, and where the pitch requires it is covered with sheet-iron to allow the coal to slide over it more readily. C is the "battery"-prop; the entire shute being closed with plank, except an opening to allow the coal to pass through, which stopping is called the "battery."

Where the top rock is strong, it will not break down until there has been a great deal of coal excavated beneath it;

but when it does start, the crush is much greater than it is where the top is weak and falls in short distances, before large excavations are made, filling up the vacant spaces with masses of rock, which act as supports. In the former case it may happen that the pressure will be so severe as to crush the coal when it is left standing for some distance, into the solid; a coal support, therefore, that is intended to confine a crush within certain limits, will require to be stronger where the top rock is strong, than it will where this is weak.

As the gangways are the only channels for the coal to the outlet, they must be kept open at all hazards; and where the top is strong, the "stumps" or coal supports along them (A Fig. 8) should be as large as economy will allow; say 10 to 15 yards; when the top is weak they may be only 7 to 10 yards.

The character of the top generally requires the breasts to be timbered (single timber or props, 6 inches diameter, being used), and where the pitch is great, the labor of conveying this timber from the gangway to the face of the breast, which must be done by hand, will limit the length of breast to that distance beyond which it would be too costly an operation. On the other hand, when the pitch is so slight that the cost of carrying timber is much reduced, the coal mined must be pushed or "buggied" from the face of the breast to the gangway, as it will not descend by gravity, and the cost of this will limit the distance to which breasts may be profitably driven. The length of breast in pitching seams found most convenient is about 80 yards, shutes included, but this is sometimes slightly varied.

The width of breast varies with the nature of the top and bottom; the stronger the top the wider the breast, but they are never driven less than 6, or more than 12 yards wide.

This statement apparently does not agree with the one above, that the stronger the top, the stronger should be the coal supports; but the two cases are not similar. A breast need be kept open only while the coal is being mined in it, and when that is exhausted, it is of no further use, while a gangway must be kept open as long as any coal can be mined above it, and the distinction drawn is between a tem-

porary and a permanent security. Another difference is, that when the top is bad and liable to fall in short distances, portions of the rock or slate may fall and mix with the coal mined in the breast, causing serious trouble to separate again; therefore, in the case of the breast, the excavations must be smaller, as compared with the strength of the support, than when the top is strong; while in the case of the gangway, the liability of the top to fall in short distances relieves the weight, and the coal supports need not be so large as where the top is strong.

Breasts are worked by the miners under either of two arrangements, according to the requirements of the seam:

1. "By the run," as it is called, where they receive a sum per lineal yard for driving a breast of a specified width, it being the duty of the mine boss to see that the proper width is maintained.

2. "By the wagon," where they receive a sum per wagon for properly cleaned coal, the width of breast and lineal distance not entering into the account.

Breasts are worked under the first arrangement only where the pitch is so great that the men working them cannot keep up to the face of the work without supports, or, in other words, where the pitch exceeds 40°.

Breasts worked by the run may be opened in several ways; the most commonly used are illustrated in Figs. 12 to 19 inclusive.

In the plan shown in Fig. 13 which is the one most frequently used, four strong props (of 8-inch timber) are set at *a a* and *a a*, just above the stump. Against these, two log batteries (*b b*) are built, in each of which an opening is left that will permit large lumps to pass through freely, say four feet square. The miner then starts his work, and the coal cut is allowed to fill the space excavated, just enough being drawn from the shutes to leave room at the face for him to work. It is, however, necessary to provide means by which air shall be supplied across the face of the breast, and this is done by keeping a small opening on each side of the breast, marked D, so that the air may ascend on one side, cross the face, and descend on the other. The arrows

indicate the course of the air. These openings are called manways, and are timbered in the manner shown, being made as near air-tight as possible, with 2-inch plank nailed against the upper side of the timbers. It will be observed that each timber is notched into the pillar to keep it in place. These timbers are called "jugglers," and are set four, five, or six feet apart, as may be most convenient for the men in carrying up the planks.

As the driving of the breast progresses, the manways are constructed, and should never be allowed to be more than six feet from the face. The great body of the coal is retained in the space marked "loose coal," until the distance is reached to which it may be desired to drive the breast, in order that the men may have a support to keep them up to the face on which they work. After that distance is reached, the coal is drawn from the openings in the log batteries *b*, until it is exhausted. It will be observed in this method that in case any accident should happen by which one of the manways in a breast should be obstructed so as to prevent or very much lessen the circulation of the air at that point, all the breasts inside of it would be deprived of ventilation until it was repaired. This, in seams making much fire-damp, would be a most serious delay, and the plan shown in Fig. 15 is used to overcome this defect.

The breasts are started with only one shute, which is in the center, instead of two, one in each side. At the heading, three strong props (*a*) are set to sustain a log battery, which may have one or two openings to draw the coal from, as may be desired. The breast is gradually widened in the manner shown, until the full width is reached, the manways D being timbered and planked as in Fig. 13. At the center (*a*) of the three props, a stopping is put in which turns the air up into the inside manway, and it is carried across the face and down the outside one, as shown by the arrows.

Should any accident obstruct either of them by opening the stopping *a* across the heading, the breast can be isolated and the current pass on to the next one, until the damage is repaired. The two manways D are made to diverge from

a single shute, in order that the excess of loose coal over that necessary to keep the men at the face may all be delivered at the bottom, through them into it if necessary. It is necessary to draw the excess of coal from the manways, instead of the breasts, when the top or bottom is bad, or both, because—1st, the jugglers being notched into a soft material, are liable to become unseated by the moving mass of coal, and as it is necessary that the excess should be removed every day as fast as it is made, repairs would be required to the manways daily, and this while the miners were at work in the breast. 2d, there is less liability for the moving mass of coal to rub off or dislodge portions of the top or bottom if the mass of coal lies perfectly quiet until the breast is finished, and then is drawn out as rapidly as possible, than there is if it is moved a little each day; and should the jugglers become unseated after the breast is finished, and the men are out of it, no difficulty arises, as ventilation is no longer required in the breast.

As the coal shute is always more or less full of coal, a smaller shute is driven from the gangway to the heading between each two breasts, and is used by the men working as a traveling way both to and from their work.

Fig. 14 shows a plan in which an additional stump A′ is left to keep open the heading which is continued across the breast. The stopping *a* in the heading opposite the center of the breast, if removed, would isolate the breast in case of accident as above. As this coal can all be taken eventually, there is no loss in pursuing this course.

Figs. 16 and 17 show a system pursued in thick seams sometimes, where large quantities of gas are made. I have shown the gangway as driven against the top, which is sometimes done to give greater security to the gangway, and also in order on very steep pitches to allow the shute to be at such a grade as will permit the coal to be under the control of the loader in its passage from the breast to the wagon. The main feature of the plan is an air course *c*, driven against the top above the gangway, and connected with the manways EE, between each breast, by the passages FF. When the breasts are in operation the air-course *c*, called a

"monkey gangway," is not used, the arrows in black indicating the course of the air; but when it is necessary to repair one of the manways DD, the course is shown by dotted arrows. The great advantage it has is in securing a permanent return for the air after the breasts are exhausted.

The coal made along the manways D may be drawn from the manways E. The main shute, marked "coal shute," is driven large (9 feet wide), and has a traveling way on one side to allow a man to attend to the drawing of the coal.

In many cases all the coal in excess of what is necessary to keep the men up to the face is drawn from the breast shutes, and not from the manways, in order—1st, that the manways may not become obstructed; 2d, that the coal in falling on steep pitches may not be broken. Where this coal is thus drawn, it is desirable to draw from a center shute, instead of two side shutes, as there is a tendency in the moving coal along the manways to unseat the jugglers, which may be partially overcome by driving a third coal-shute between the two shown in Figs. 13 and 14, and drawing the excess of coal from it. This has a tendency to allow the coal along the manways and against the sides to remain at rest while the motion takes place down the center of the breast. In all places where the bottom is bad, and the breast requires to be emptied as soon after it is finished as possible, three shutes are a great advantage, as three times as much coal can be loaded from them in the same space of time as there can from one.

Figs. 18 and 19 show rather more in detail a modification of the same plan now very extensively used in the mammoth seam where it is of great thickness and steep pitch. As in the previous case, one shute between two breasts serves for the passage of men to both, but the "slant shutes" as they are called diverge from it over to the breast manways at such a grade that any coal desired to be sent down the breast manways is not delivered into the main coal shute but into the shute between the breasts. The advantages are that when the loader is at work drawing coal from the battery, the manway coal coming down does not interfere with him, and the miners always have

free access to and from the breast even when coal is being drawn from the battery.

Under some conditions of seam working by the run, it is desirable not to make any juggled manways along the sides of the breast, but to drive a manway up the center of each pillar in the upper bench of the seam, as far as the breast extends, headings being driven every 16 yards into the breasts on each side of the pillar. The headings are driven alternately one every 8 yards, the first into the breast on one side, and the second into the one on the other side, and so on—and are driven near the top because the loose coal in the breasts will not cover them there as soon as if they were on the bottom, and the manways must be driven near the top because the headings are.

It will be seen that in all plans of working by the run, there is no opportunity to leave in the breast any of the impurities contained in the seam; everything must be taken out with the coal. As shown in the sections, Fig. 20, the amount of unprofitable material necessary to move in some cases is excessive. As the breast must remain full of loose coal until it is driven to its destination, there is always a liability of portions of the top or bottom becoming detached and adding to the impurities, and in some cases these causes operate so seriously against working by the run that it is impossible to use the plan.

When the impurities are so great that they will fill up the space indicated in Figs. 12 to 19 inclusive, as being filled with loose coal, so as to keep the men up to the face of the breast, the good coal may be thrown down the manways, and the breast worked in that way until it is finished. If there are not enough impurities to do this, breasts on steep pitches are worked "on batteries," as it is called, where the thickness of the seam is not so great that it cannot be timbered. When the seam is over 12 feet, and so impure that it cannot be worked by the run, it is now considered not workable, and must be abandoned until some improvement in our system of mining is made; seams of 12 feet and under 12 feet in thickness may be worked on batteries. Figs. 21 and 22 illustrate the course pursued. Rows of

props of 6 to 8-inch timber are set across the breast every 15 to 20 feet up the pitch as it progresses, and a few planks or laggings nailed on them, making a platform on which the men stand to carry on the work. Two manways, here called shutes, are kept open, as in the former method, for ventilation; but it is only necessary that the inside one, or the one delivering the air at the face, should be made air-tight. As the coal is mined it falls upon the platform, and the good coal is separated from the refuse and thrown down the shutes, the refuse being thrown into the breast, where it remains, occupying the space filled with loose coal in the previous figures, and is called the "gob." Breasts worked "on batteries" are worked by the wagon. Care must be exercised, as far as practicable, to keep the jugglers and planking covered with the gob, in order that any falling portions from the top, or elsewhere, may have the force of the blow deadened, so as not to break them down, which would not only obstruct the air, but also cause the impurities in the gob to mix with whatever coal was in the shutes at the time.

Where the pitch of the seam is from 12° to 40°, breasts are worked in the same manner as on batteries, except that the platforms or batteries are not necessary, as the men can keep up to the face without assistance. In all such breasts, the central space, filled with loose coal in Figs. 12 to 15 is used to retain the waste matter or gob, and the good coal is invariably sent down the manways. There is an unavoidable waste in the passage from the face of the breast, caused by the lumps grinding together, which would be lessened if the manways could be kept full; but this cannot be done, because it would retard or obstruct the ventilation. The waste is not, however, as great as in the cases shown above, where the pitch is steeper. All breasts on these pitches are worked by the wagon, the coal that is produced each day being removed at once, and a great advantage is thereby secured over breasts worked by the run, where the coal cut must remain in the breast until it is finished, in that the liability of portions of the top or bottom to be detached and mix with the coal is entirely removed. On the other hand

wagon work while it generally wins a larger percentage of the coal contained in a seam, costs more per ton than run work. Every wagon of coal taken from the mine must be paid for at a fixed rate, and the benefit arising from a free working breast will largely accrue to the miner working in it, while in run work the coal in a breast if free, may after a few yards have been driven at a fixed rate start to run from the face and continue to do so, requiring no further driving and yielding as much coal as one driven its full distance, which would obviously be to the advantage of the proprietor.

From 12° to 28° the shutes must have sheet-iron laid on the bottom, as the coal will not slide on the irregular floor of the seam, and on the lighter of these pitches, say from 12° to 18°, it must be pushed by hand down on the sheet-iron.

Figs. 9, 10, and 11 show a breast worked by the wagon, on such a pitch as will allow the coal to run by its own weight to the gangway.

Figs. 27 and 28 show a method of working breasts where the vein is not large, the pitch light, and the top liable to fall. A shute is driven from the gangway up the pitch as far as it is desired to work the coal, and timbered just as the gangway is timbered, except that it is not so large. As indicated in the drawing, mining is begun at the extreme end of this shute, the breast being opened out full width and worked backward towards the gangway. The advantage secured is that between the miner and the gangway there is always the timbered shute as an outlet for himself and the coal he mines, which could not be maintained if the full width of breast were driven as in the preceding cases, owing to the bad top. Props of 6 to 8 inch timber are set close to the face of coal which is being mined, and are sufficiently strong to prevent the top breaking so close to the face as to injure the miner, while in the exhausted space it is allowed to fall at pleasure.

If the pitch were so steep that this fallen top would slide on the bottom down to the face of coal on which the men were at work, this plan could not be used, and the pitch

selected in the illustration is such as to require sheet-iron in the shute, for the coal to pass over to the gangway.

From 6° to 12° of pitch, the breasts are worked with "buggies," which are small wagons running on a track, and pushed up to the face, loaded, and lowered to the gangway, as required. They do not generally hold quite a ton, and sometimes only half a ton. The rails may be of iron or wood, the latter being preferred in the steeper pitches, because there is greater friction between it and the wheels, and the loaded buggy is easier to handle.

The coal is dumped on a platform, from which it is loaded into the wagons on the gangway with shovels. Figs. 23 and 24 show the arrangement. As much room is secured in the dump as the top will allow, in order that the platform may hold as much coal as possible without additional handling, so that the miners may be enabled to continue their work should any accident cause delay to the gangway wagons, and consequently prevent the removal of the coal on the platform for a few hours. Buggy breasts are always driven with single shute, and the refuse thrown to one side out of the way of the road.

When the pitch is flat to 6° the wagons are taken directly into the face and loaded there. Such breasts are called wagon breasts, and are turned with single shutes, not at right angles to the gangway, except where the pitch is flat. Figs. 25 and 26 show the arrangement. In flat work the gangways frequently rise at quite steep grades, sometimes 2 to 4 degrees, and each breast is also usually driven at such a grade as will permit the loaded wagon to descend by gravity, so that after it has been hauled empty to the face it is not necessary for the driver to return with a mule for it, thus saving time and labor. An advantage in overcoming these grades is obviously gained by turning the breasts towards the outlet, as shown in the figure, instead of away from it, which would appear to be the most natural direction for them to take.

Where the top is bad, the road is laid along one of the pillars to gain greater security, and the refuse or gob matter is thrown to one side, out of the way of the road.

Wagon breasts are frequently driven to much greater distances than any of the others, as the objections to doing so that were valid in their cases do not exist here, the timbers being hauled in in the wagons, and the coal hauled out.

Although many plans of working breasts are followed, I think those here shown will give the most common ones, as well as those most profitable, and the variations are not essential. I have purposely left out the method called "panel workings," as it is yet but an experiment, and has not been adopted in practice with us.

It is usually customary to open and work the breasts on the gangways as they are driven, so that shortly after the gangway has reached the point to which it is desired to drive it, the breasts are all finished. Whatever coal it may be possible to obtain from the pillars is then taken out, beginning with the last breast and robbing out to the outlet. It frequently occurs that this system of working out the breasts as the gangways progress, so weakens the supports to the top as to bring on very serious crushes. Sometimes it is possible to meet this difficulty by setting new timbers in the gangways, but in some cases the gangways have been abandoned at serious loss. Benefiting by an experience so gained, there are collieries in which the gangways are first driven to the limit before any breasts are opened; then work is begun at the inside of the gangway, as many breasts being worked at a time as the capacity of the preparing apparatus requires; say, where two gangways only are driven, 10 to 15 breasts in each, and the pillars are robbed there, and all the coal obtained that is possible before opening breasts in another section.

As the gangways, shutes and headings, or "narrow work," as they are called in general, do not pay for the expense of driving, such an operation requires a large outlay of capital before any return is obtained.

In order to secure these advantages without so great an investment in narrow work, Mr. Jno. Veith, General Inspector of Mines for the Philadelphia and Reading Coal and Iron Co., proposed to increase the length of gangway

stump to such a size as would insure the security of the gangway, and at the same time permit both the breast and pillar coal to be taken out as the gangway advances. In order to prevent any extraordinarily heavy crush affecting the gangway and working breasts, barrier pillars 50 yards wide are left at intervals of 200 yards along the gangway. The plan has been in use for over two years, and gives very excellent results. Where formerly the standard length of gangway stumps was 10 yards, it is now from 15 to 20.

Gangways are driven as far as economical working will allow, or until some natural boundary, such as an anticlinal or synclinal axis, where the seam is in fault, is reached, or a fault too large to drive through profitably. The limit to which a gangway may be driven will depend more upon the condition and size of the seam, and the character of its upper walls than upon the mere distance to move the coal. In other words, the cost of keeping open a gangway will limit the distance to which it may be driven, natural boundaries excluded. Where seams are thin, and contain strong coal to keep gangway stumps intact, with good slate or rock top, the cost of repairs necessary to keep gangways open will not be large, and they may be driven for two, or even three miles profitably. But in large seams, even under the most favorable circumstances, one to one and a half miles will be all that can be maintained with advantage, and where the conditions are unfavorable, half a mile will be ample. Since the coal lands have become the property of large and wealthy companies, much of the evil that necessarily arises from property restrictions on the natural location and extent of collieries has been done away with, and improvements are now perpetuated by giving them all the coal within their natural scope, irrespective of property limits. The tendency therefore is to diminish the number of collieries hitherto in operation, and increase the capacity of those advantageously located; and greater lengths of gangways, improved methods of keeping them open, and increased facilities for mining coal to greater distances, are among the requirements of the future.

It sometimes happens that it is desired to locate the lower

terminus of the outlet at such a level as will give two or more lifts above it, or the dip of the seam may become so much flatter as, in the same vertical height, to give much greater length of breast on the dip. Assuming the dip at the outlet to be 60°, and that in one of the gangways it flattens to 30°, the length of lift which was 100 yards at 60° will be obviously very much increased beyond the distance that can be profitably worked from the gangway. Under these circumstances it is customary to lay tracks in one of the breasts after it is finished, and convert it into an inclined plane which is operated by gravity, the loaded wagon hoisting the empty one,—all the machinery consisting of a drum, on and off which the ropes are wound, and a brake to regulate the speed. Gangways are driven from the top of the plane, similar to those described above, and the same course of mining is pursued. The steepest inclination I have known a gravity plane operated on is 41° (although with competent brake there is no reason why this should not be increased,) and the slightest is 5°.

In cases where the pitch is too steep for a plane, or where the expense of one is not desired, the coal from the upper gangway is dumped into an empty breast and loaded therefrom into wagons on the gangway below. Such a breast is called a "counter-shute," and the upper gangway a "counter-gangway." As there is no provision in the counter-shute plan for getting the timbers necessary up from the lower gangway, they are sometimes put off the wagons on the outlet (if a slope) at that level, and if this cannot be done must be either lowered from the surface or hoisted from the bottom level by hand. Where the dip is not so steep that it will take harm from the speed at which it travels, it may be allowed to slide down an air-way or some suitable opening; or if the dip is too steep, a small plane with 2½ to 3 feet guage may be laid in the opening, and the timber lowered by gravity on trucks made for the purpose. Where neither of these appliances are used, the timber and rails must be either hoisted by hand with a windlass, or carried by men up to the counter-gangways, and the wagons also must be taken to pieces and carried up, all

of which adds to the cost of the counter coal, besides the unavoidable waste there is from the tendency to grind into dust in the passage from one gangway to the other in the shute. The latter evil is in part obviated by keeping the shute constantly full, so that the velocity and consequent loss of the moving mass is reduced to a minimum.

It will be observed that in the system of mining pursued with us, the direction of the "cleat" or "slips" does not influence the course in which the breasts are driven—as it does in bituminous coal mining; and the reason is that our steep angles of inclination do not admit of any variation of the rule laid down above in working breasts, within any practicable limit of economy. Furthermore, as anthracite is so hard as to require the use of powder, in almost every case the benefit derived from the cleat is not as great as in softer coals requiring little, if any, blasting. However, our miners always take what advantage they can in locating and charging their shots with reference to it.

When the gangways have been robbed back to within as close a distance to the outlet as is deemed safe for its stability, the work is finished at that level, and the gangways need not be kept open unless they are to be used as water or air courses. It was considered formerly desirable to keep the water produced at each level at that level, and not permit it to go lower, making thereby less work for the pumping apparatus to do; and it was therefore generally necessary to keep old gangways open as water-courses, where possible. It has now been determined by experience that in thick seams the amount of coal lost in the endeavor to keep up water at different levels, which is not successful for more than a very few years, is an unnecessary and extravagant waste at all levels except the water level, and it is no longer attempted.

After the one or two lifts (as the case may be) that have been developed by the outlet are exhausted, it is continued to another lift, or more, as may be desired, when the same course of mining is pursued.

Fig. 31 is a plan on the plane of a seam, and shows the method pursued in sinking the outlet (assumed to be a slope)

for new developments, with regard to the amount of coal left to sustain the old level and the ground taken for the new.

Very generally over and under lying seams are developed and worked by tunneling from the seam on which the outlet is located.

The dimensions of tunnels in use by the Philadelphia & Reading Coal and Iron Co., are given in Figs. 29 and 30.

Unless the distances are unusually great, these tunnels are driven by hand, as air-compressing machinery necessary to drive rock-drills is not generally used at the collieries for other purposes, and the expense of putting it up for tunneling alone would so much increase the cost of the work as to overbalance the advantage in time saved.

I desire in conclusion to acknowledge with thanks the advice and assistance of Mr. Thos. Doyle, Assistant Mine Inspector of the Philadelphia & Reading Coal & Iron Co., in the original preparation, and of Mr. Jno. Veith, General Mine Inspector of the same company in the present reproduction of this sketch on coal mining.

Chapter III.

How Anthracite Coal is Prepared.

Anthracite coal, before being shipped to market, passes through a "breaker." An illustration, showing the breaker of the Hammond Colliery, is appended to this volume. This plate, and the description below, are taken from the report of H. S. Thompson, Mining Engineer of the Girard Estate.

Coal, as it comes from the mines, is of all sizes mixed together, from lumps of one ton in weight down to fine powder, and carries with it harder impurities, such as slate, and rock, which generally occur in seams of coal and cannot convenientiy be retained in the mine, also varying in size from minute particles to slabs weighing nearly a ton.

Coal so finely broken as to pass through a screen mesh three eighths of an inch square is usually called "dirt," and is, at present, largely a waste product. It occurs quite often in the seam *as dirt*, but is more largely produced by the crushing of the coal, during the process of miuing, handling, and transporting.

The purposes for which a breaker is required, are:—

First. To separate the dirt, slate, "bone," and rock, from the coal.

Second. To separate small coals of different sizes from each other.

Third. To break down such pieces as are too large, into suitable sizes.

And it is desirable that these requirements should be fulfilled with as little cost of handling and waste of coal as possible.

At the Hammond Colliery the product of the mine is raised through the slope in small cars, called wagons, which run by gravity from the head of the slope to the breaker tips or dumps, two in number, A. A., where they are dump-

ed and emptied in the manner shown. The empty wagons are pushed back by hand to the foot of the automatic plane B., by which they are raised to a height sufficient to allow them to return by gravity to the head of the slope.

The mixed coal, slate, and dirt taken from the mine enters the "dump shute," C. C., and reaches first the "main dump shute bars," C¹., which are narrow cast iron bars, so set as to allow a space of two and a half inches between each two of them. Most of the material small enough to do so, passes through these bars to the dump shute "hopper" D., from which it is fed into the counter screens, E E., one on each side, with their supplementary screens, E¹. E¹., and E². E². All breaker screens are circular, revolving and slightly inclined away from the end at which the material to be screened is allowed to enter, so that whatever will not pass through the meshes, descends gradually, as the screen revolves, to the other extremity and drops out. They are divided into as many compartments, called "segments," as required; and covered with wire meshes of different sized openings. The smaller mesh, being placed next to the end at which material is fed into the screen, extracts the dirt and allows all larger sizes to pass to the next segment, which extracts the next size, and so on.

In the counter screens, E. E., the first segments extract all smaller than, and including, the chestnut coal. The pea coal and chestnut coal are separated from the dirt in the supplementary screens, E¹. E¹. The other segments separate the large and small stove from the egg coal and larger pieces, which pass out at the ends of the screens, while the stove coals are again cleaned of smaller particles and flat slates in the supplementary screens, E². E².

The dirt from all these screens passes down the counter dirt shute, D⁵., and is hauled away on the tramway, Z., across the trestling, Y. Y., to the dirt bank, in small cars, which may be tipped on either side, called "dumpers."

The slate and bone separated from this coal in part by the so-called slate picker screens, and in part by hand picking, containing a considerable quantity of good coal mixed with or adhering to it, is collected in the slate picker hopper,

D., from which it is taken along the tramway, Z^1., to the boiler fires, and used as fuel.

When it leaves the counter screens the coal descends, by its own weight, along narrow troughs, F. F., called "telegraphs," the hand picking being done by men and boys at convenient places along them, and is distribuetd thus:—the pea and chestnut to the main pea and chestnut coal screens, L^1. L^1. L^1., the large and small stove to the main screens, L. L., and the egg and broken to the prepared coal rollers, K^1.

As the counter screen material is usually wet, and the dirt adheres to it, this second screening is necessary in order to clean it properly. This completes the distribution of that portion of the wagon contents which passes through the two and a half inch openings between the bars, C^1. C^1., which is only the smaller sizes from egg down, with such of the larger thin slabs of coal as may turn edgewise and pass through the bars.

That portion of the wagon contents which passes over the bars, C^1. C^1., goes to the steamboat bars, C^2., (on its way down to the dump shute), which are set four and a half inches apart. All that passes through the bars, C^2., goes to the bars C^3., set two and a half inches apart, through which all below, and including, the egg coal passes to the dirt screens E^3., where the dirt is separated from it, the coal going to the prepared coal roller, K^1., and main screens, L. L., while the dirt goes into the hopper, D^4., and thence to D^5.

In this process coal that should have passed through the bars C^1., but has been crowded over them, is separated in the dump shute, C. C., by bars C^2., and is removed and distributed as described. That portion which passes over the bars C^3., goes to the principal steamboat bars, C^4., where it joins the coal from the steamboat roller, K. The remainder of the wagon contents goes down the dump shute to the platform bars, C^5., and contains nothing smaller than lump coal. The platform bars are set nine inches apart, and that portion which passes over them goes to the first platform, H., where such of the lumps as are suitable are pushed into the lump coal shute, I., and the slate and rock into the rock

shutes, I¹. I¹., on either side. Here also such of the lumps as have streaks of slate or bone through them are broken by hand and the impurities removed. All that is not suitable for lump coal is thrown down a hole in the platform to the second platform, H¹., where it joins that which passes through the bars, C⁵. Here the slate is carefully picked out again by hand and sent down the rock shutes, I¹. I¹., to the point, I²., where it is loaded into dumpers, and hauled to the dirt or rock bank.

The lump coal passes down the lump coal shute, I. I., to the point, I³., where it reaches such a level as will allow it to be loaded into the railroad cars for market. After the slate has been removed at H., the coal is thrown down a hole in the platform to the steamboat rollers, K. These rollers are cast iron cylinders, with large strong teeth, which revolve towards each other at a speed of from ninety to one hundred and twenty revolutions per minute, and the coal dropping between them is broken into pieces of various sizes. The two rollers are set so near together that none of these pieces shall be larger than steamboat coal. The coal passes from the roller, K., to the principal steamboat bars, C⁴., set four and a half inches apart, and all that will not go through them is steamboat coal, and goes to the steamboat shute, G., whence it is loaded into the railroad cars at G¹., in the same manner as is done with the lump coal at I³., the same track answering for both. That coal which passes through the steamboat bars, C⁴., goes to the prepared coal rollers, K¹., which are similar to the steamboat rollers except that they have smaller teeth, and are set nearer together so that they produce no coal larger than broken. From these rollers the coal enters the main screens, L. L., which are similar in construction to the counter screens described above, except that they are larger. The dirt and pea and chestnut coals are taken out in the first three segments, and go together to the pea and chestnut screens, L¹. L¹. L¹., which are double screens having a surrounding mesh, outside the screen, called a "jacket." All but the chestnut coal passes through the inner screen, the chestnut dropping out at the end, and the dirt passes through the

jacket, while the pea coal drops out at the end of the jacket. The dirt drops into the dirt hopper, D²., and is hauled to the dirt banks; the pea goes to the pea coal bins, N⁶., and the chestnut to the chestnut coal bins, N⁵., without further preparation.

The next segment in each main screen separates the small stove, the next the large stove, the next the egg, and the broken coal falls out at the end.

All the coal but the broken, passes, each size separately, over short "dusting bars," M¹., set three eighths of an inch apart, which remove the dirt made by attrition in the screens, and thence over the picking floors, M. M., which are so inclined that the coal slides over them by gravity, each in its own compartment.

These compartments are—

M⁵. M⁵., small stove picking compartment.
M⁴. M⁴., large " " "
M³. M³., egg " "
M². M²., broken " "

Across the picking floor, seats, M⁶. M⁶., are placed, which are slightly elevated above them so that the boys who pick the slate sit above the coal and separate the slate from it by hand as it passes them on its way to the bins. The slate picked out by the boys is collected in the slate shutes, M⁷. M⁷., and carried by hand to the dirt hopper, D².

The bins, N. N., are divided into compartments for each size of coal, N¹. N¹., being the broken coal bins; N². N²., the egg coal bins; N³. N³., the large stove coal bins; N⁴. N⁴., the small stove coal bins; N⁵. N⁵., the chestnut coal bins; N⁶. N⁶., the pea coal bins; N⁷., the buckwheat coal bin. When it is desired to load this coal into the railroad cars, they are run down under the breaker to the gates, O. O., communicating with each bin, the car loaders using the platform P., for convenience in walking from bin to bin. Below each of the gates, O., is a short set of bars over which the coal passes on its way into the cars, called the "lip screens," which take from each size all particles smaller than it, as well as the dirt caused by attrition in the bins. There are also similar bars at the lump and steamboat loading points,

I³. and G¹. All this "loading chippings" and "dirt," as it is called, are brought to the hopper of the elevators, R. R., the lump coal chippings by means of the swinging trough, S.; the steamboat chippings by a trough not seen in the drawing, and the dirt from the lip screens, at O. O., by wheelbarrows. It is then all elevated by the elevators, R. R., and carried horizontally by the chain carriers, T. T., to the bars, V. That which passes over the bars goes to the so-called "monkey rollers," K²., which are similar to the others described above, but smaller; while that which passes through goes directly to the elevators, R¹. R¹. After passing through the monkey rollers, that portion goes also to the elevators, R. R., and all together are elevated to the buckwheat screen, W. All but the dirt and buckwheat coal passes through this screen and goes to the main screen, L. The buckwheat passes through the screen and drops from the jacket to its proper bin, N⁷., while the dirt passes through the jacket and goes to the hopper, D².

This completes the distribution of all the coal. It will be observed that in all the operations advantage is taken of the elevation of the tips A. A. above the railroad tracks to cause the coal to pass from one process to the next, continuously, by gravity, and the elevations necessary to do this are reduced to a minimum by covering the shutes and traversing floors with sheet-iron, which soon becomes highly polished.

The machinery is all moved by the stationary engine, at K., with its belt and shaft connections.

Chapter IV.

Waste in Mining Anthracite Coal.

There is no possibility of arriving at an exact average waste percentage of coal lost in the mine in working anthracite coal.

For the percentage of mine waste in working the Mammoth bed when it is 45 feet thick, is very different from the mine waste in working the Wharton bed 8 feet thick, or the Lykens Valley bed 8 to 10 feet thick.

And there is an equally wide variation in working the same bed in two collieries, in one of which it lies horizontal and in another dips 60° to 70°.

The obstacles in the way of mining are thus briefly stated by Mr. Eckley B. Coxe.

"Before giving my ideas as to the proportion of coal obtained from any vein, I shall state some of the circumstances which influence the percentage of waste.

1. The thickness of the vein.
2. The nature of the roof.
3. The pitch of the vein.
4. The amount and nature of the intercalated slate and bony coal.
5. The nature of the coal, as affecting the uses to which it is put and consequently the sizes in which it is used.
6. The nature of the coal as affecting its fracture and also the breaking machine.
7. The methods of working adopted.
8. The question of the cost of labor, timber, and transportation.

1. The thicker the vein after you pass 6 to 8 feet, the less the percentage of coal you get. In a small vein, with a good roof about two thirds can be taken out at once and most of the pillars can be gotten.

When the vein is thicker much larger pillars must be left,

the breast must be arched, and much larger quantities of coal must be left for gangway, slope, chain, and other pillars.

2. If the roof is good most of the coal in the breast can be gotten, but if it is bad part of the coal must be left to support it, and much coal is often lost by the roof falling and burying coal under it.

3. The steeper the pitch in general, the less the percentage of coal in the vein that can be gotten.

In flat places the breast can be kept regular, the coal can be well and carefully cleaned, much less amount of coal is needed to keep up gangway pillars, &c.

4. The purer the vein, that is the less slate and other impurities are in it, the less the waste. If for example a vein is all coal everything can be loaded out, but if twenty per cent. is slate there will be a large amount of coal left in the breast which is so intimately mixed with the slate that the miner cannot clean it, (of course in steep breasts where everything is loaded into the mine cars the same difficulty occurs at the breaker,) much coal therefore is left attached to the slate, as a miner cannot be expected to spend eleven cents' worth of labor to get ten cents' worth of coal.

If the slate on the other hand breaks into large solid pieces parting from the coal, more coal will be gotten as the miner can separate it easily from the fine coal.

5. Where a coal, for example the Lykens valley anthracite, is used for such purposes as to render it salable only in egg and smaller sizes, there must under the circumstances be much greater waste than where, as in the Big vein of the Lehigh region, the coal is largely used in the form of Lump, Steamboat and Broken. Moreover where coals are of good quality for generating steam, much smaller screens can be used in preparing the buckwheat coal and a larger percentage obtained.

6. Some coal breaks with much less waste than others, that is much less fine stuff is made, and some breakers, particularly the modern rolls with steel teeth and high speed, make much less waste than the old fashioned ones. Now as all collieries must break more or less to supply their trade, this is an important factor.

7. The more or less perfect systems of mining, and the taking advantage of all chances, such as the leaving large pillars where the coal is poor, avoiding premature caving in, &c., &c.. having work enough opened ahead so that the robbing need not be begun too soon, &c., the leaving of sufficient pillars, but only where they are needed, &c., have a very important influence on the output.

8. The question of the waste is to a large extent dependent upon the cost of labor, timber and transportation and the price of coal, for the cheaper timber the more we can put in, the cheaper labor the more carefully we can work and the higher the price of coal and the lower that of transportation the greater the royalty and consequently the greater the amount of money we can afford to spend to save the coal.

There is another point to be remembered that all esti mates of coal extracted are based upon railroad weights, and that all coal lost or stolen from the cars, between the colliery and the weigh scales goes to the account of waste in mining and breaking; *secondly*, the Railroad Companies formerly allowed five per cent. and now about three per cent. to make up for loss in transporting and shipping coal after it passed the weigh scales: *thirdly*, generally no account has been kept of the coal used at the collieries for steam, &c., and for employés use; all these items are thus charged to wastage.

With reference to general results at one of their collieries where a considerable area has been worked over, Mr. Coxe says:

"Roughly, upon excavation of a little less than 200 acres, the shipments are over . . . . . 2,000,000 tons, with the vein not over 10 feet thick on the average.

"The vein is not all worked out in the 200 acres, but there are many breasts unfinished, and some parts unopened; and there is much coal to be robbed.

"The average yield is at least 10,000 tons per acre—
or *1000 tons per foot per acre;*
or 1 ton at least for 43½ cubic feet.

"No deductions have been made for faults. The specific gravity of the coal is 1.6."

Mr. T. D. Jones, the Mine Inspector of the Lehigh region, gives the following figures as the percentage of coal in the ground now actually won out by collieries working the different coal beds named and on the differing dips:

	Vein worked.	*Av. thickness.*	*Inclination.*	*Per cent. won.*
1. Lehigh Region,	Mammoth, E.	28′	45°	60
2. " "	" "	28′	Horizontal.	70
3. " "	" "	28′	Vertical.	70
4. " "	Wharton, D.	8′	Horizontal.	90
5. " "	" "	8′	45°	80
6. " "	" "	8′	Vertical.	90
7. " "	Buck Mtn., B.	12′	Horizontal.	80
8. " "	" "	12′	45°	70
9. " "	" "	12′	Vertical.	80
10. Nesquehoning,	Primrose.	16′	Vertical.	85
11. "	Mammoth, E.	50′	Vertical.	70
12. "	" "	28′	45°	70
13. Summit Hill,	" "	60′	45°	55

Mr. Jones says: "It may be said by some that my estimates are too high, but, when we take into consideration the improved methods of mining of late years, and the care that is exercised to mine all the coal that is available, compared with the old mode of mining, 'take it where you can get it the easiest and cheapest,' it is not any too high, at least in my estimation."

The Mammoth coal bed is of unusual size where it is worked by the collieries of the Philadelphia Coal Company at Lost creek.

Concerning the mine waste, their superintendent, Col. Brown, says:

"Packer colliery is mined on the breast and pillar system, the vein and top being favorable. We estimated that the portion of the vein mined is about 60 per cent. of the whole seam—that is of the portion exhausted."

This is a good average for "breast and pillar" working on so large a vein, but everything in the vein is especially favorable to this system, for the vein is solid; there is very little shelly coal; the top coal forming the roof is strong; while the pitch, 25° to 30°, suits the system of mining by

long breasts. Of the 40 per cent. lost, 30 per cent. represent the amount left in pillars, and 10 per cent. the top coal left in mine.

A larger percentage would come out of the mine if the top benches of coal, which are usually unmarketable, and contain more refuse than the rest of the vein, were not included in the measurement of thickness.

We mine by breasts 30 feet wide, leaving a pillar of about 25 feet between breasts, the breasts, according to pitch, being from 300 to 540 feet long.

When the breast is driven up to the chain pillar, next to water level, we commence about half way up the breast and skip (as it is called) the pillar, that is, take off about two thirds of its thickness; this is done frequently with a number of breasts before the top coal falls or the pillars show signs of squeezing, say $\frac{3}{4}\times\frac{30}{55}+\frac{3}{6}\times\frac{25}{55}=\frac{9}{22}+\frac{3}{11}=\frac{165}{240}=68$ per cent.

When the top coal falls, if the roof slate does not fall in too large quantities, we frequently take out of the fallen breasts sufficient to about compensate for pillars left unskipped and for gangway pillars.

The foregoing summary of operations of the four collieries under my charge is based on approximations and data that I have collected during my connection with the mining of coal in this region, and a long experience in mining south of the Broad Mountain.

With regard to the *Panel System of Mining* for working the Mammoth Vein, I would refer to an article published by me in the *Miners' Journal* of January 20, 1870, and also in the Miners' Journal Coal Statistical Register for 1870. The latter article describes the system thus (see accompanying Figures):

To work the Mammoth Vein where it is of its usual thickness, and pitching at an angle of from 15° to 45°, after sinking the slope or shaft to the vein, open out the gangway or air courses on the plan at present adopted; but instead of opening out a shute every eight or ten yards along the course of the gangway, I would recommend the driving up a manway, say at the proper thickness of pillar, from slope

or shaft, (thickness to be according to solidity of coal,) and at a distance of say fifty yards from this manway, drive up at right angles to the gangway, if the pitch be under 45°, a shute of from 6 to 15 feet wide, to the upper level or surface of the mine, and make this shute the center of a panel of work, and at the distance of another fifty yards drive up another manway, completing the panel.

The center shute to be made to run coal freely, so as to load coal from it with the smallest possible labor.

This shute should have a traveling way alongside, so that the workmen can have easy access to their work, up and down by the shute.

At right angles to this center shute, right and left, small headings in the bottom bench of coal should be driven to the manway, beginning at the desired thickness of pillar between the gangway and the coal to be mined, say seven yards, and at every ten yards up this center shute drive similar headings parallel to the first, connecting them with the manway.

When all the headings are driven the panel is ready to commence mining from, and if skillful miners are employed no coal need be lost, excepting very small stumps of pillar next the shute.

To bring the coal out of these headings it would be advisable to lay a light road in them, and use a buggy wagon holding about 1500 pounds of coal; this size of wagon could be handled easily by one man.

To begin mining the miner would first open out at the end of his heading in breast fashion up to the surface or the level above; and open wide enough so that when the coal was taken out the next fall by skip off the solid would bring down the top, thus forming a sort of natural slope or shute for the next fall of coal to slide down to where the laborer could load it in safety into his buggy. The miners would always have a safe retreat into the heading when a fall of coal or rock was about to take place.

The labor of mining coal from a loose end would be very light, while the labor of loading the coal into the buggy and tipping it into the shute would be fully compensated by the

saving of expense in loading the coal from the main shute in the gangway, instead of the usual plan now adopted of loading by hand.

After a ten years' trial of the panel I find that I can add very little to the description given above, except that in some of our collieries in this valley the conditions are such that the old breast and pillar plan can be adopted as the most economical plan for mining, and with fair results as to quantity taken out.

But I reassert that for mining the Mammoth Vein, on pitches varying from 15° to 35°, the panel system is by far the best that I have tried; and where the coal is free, top rotten, and gas in the mine, it is the only plan by which over 60 per cent. of the vein can be mined with any degree of safety to workmen and certainty of keeping the mine from closing in.

The changes I have made in opening, while not altering the general plan of working, are as follows:

1. I use a blowing fan instead of a suction fan, finding better results and more certain ventilation while advancing the openings.

2. Instead of opening only a narrow passage between panels I open twin breasts about eight yards wide and a pillar five yards wide between, according to the solidity of the coal; and between each pair leave a pillar of fifty yards and in some cases sixty yards wide.

3. After these twin breasts are driven up the intended distance, the small pillar is taken out, if the top will permit; if not, we skip it until the top coal falls and so much of it as can be got at taken out of the breast.

4. While the gangways and twin breasts are being worked to the limit of boundary, a central shute 12 to 15 feet wide up on (if on a pitch greater than 30°) the bottom slate, see sketch C; if on 25° pitch, on the bottom bench, 4 feet thick, see sketch B; if the pitch is 15°, and not over 20°, then rise above the coal as in sketch A; the object of this is that the coal may slide down over the coal bottom without the use of sheet iron, and can be loaded with little expense as compared to hand loading.

5. From these central shutes we drive small gangways 7×9 feet, at right angles to the shutes at distances varying according to condition of vein, say 10 to 20 yards apart, dividing an hundred yard lift into 5 to 10 parts.

6. The half arrows indicate the course of the air during the advance and opening of the panels, while the full arrow shows the course of air when the panels are being worked home, although a portion of the air continues as shown by the double arrows traversing down into gangways and out by the slope or shaft.

7. What it costs to open the panel and buggy coal to shutes is compensated by the coal being more easy to mine requiring much less powder, timber and labor, than working coal from a solid face.

8. The cost of loading coal from the panel shute is less than a fourth of the cost of loading with a shovel, this item alone equaling about 10 cents per ton of coal.

9. The increased portion that can be taken out of the vein is an item that will amount to more than first cost of colliery, and will amply repay the operator for the additional cost of opening.

If the system of panels is properly begun and worked with a moderate degree of skill, *fully 80 per cent.* of the panel coal can be extracted; while a very large proportion of the refuse can be packed in the "goaf" or "gob" (the latter being the term in use here generally through this region.)

This packing the refuse in the mine is a large saving in handling and preparation of coal, and is fully equal to 10 cents per ton.

After reviewing the foregoing pages and the accompanying statements of the data obtained, I would add in conclusion that the four collieries named (Colorado, Shenandoah, Lehigh and Packer) are probably above the average for favorable conditions for mining, though the quantity of refuse coal and slate is perhaps greater than the average of collieries in this section of the coal region.

But for the solidity of coal they are unsurpassed in this

region, and are decidedly favorable for mining out a large portion of the vein.

Therefore the percentage of coal realized by us may seem not so large as might possibly be obtained, but I feel assured that it is about as great as we can secure, and that it is much greater than can possibly be taken out of veins that are free, with poor top and inclined to run, if worked by the breast and pillar plan.

I put down the following as my estimate for the quantity of marketable coal that can be mined from the mammoth bed in this section of the coal region. (Lost Creek, Schuylkill county.)

Mammoth, pitch	60° to 80°,	good top, worked by run,	70 per cent.
" "	40° to 60°,	" " "	60 "
" "	" "	breast and pillar, . . .	60 "
" "	20° to 40°,	" "	60 "
" "	15° to 35°,	panel system, ...	80 "
" "	60° to 80°,	poor top, coal shelly,	45 to 50 "
" "	20° to 40°,	" "	30 to 50 "
" "	15° to 35°,	panel system, and no matter how the top is, ...	80 "

The mammoth vein as mined with us (Lost Creek) will yield about 50 per cent. of the vein mined, when the whole section of vein is hauled out. If however only the bottom member of the vein is worked, the yield will be about 60 per cent. of the output.

When the whole vein is wrought the proportion of coal to refuse is as 65 to 35; of the 65 of coal about one fifth or 20 per cent. will make furnace coal, and 80 per cent., less a breaker waste of 15¼ per cent., will make prepared sizes in about the proportion given in statements concerning the collieries. (See Chap. V.)

Mr. S. M. Riley, Mining Engineer, of Ashland, Penn'a, sends the following statistics of coal actually won out and sent to market by a colliery on the Mammoth coal bed in the Ashland region:

"I have prepared, as carefully as I could, a statement of the waste in the mining and preparation of coal at the Locust Run colliery.

"This colliery is on lands of the Locust Mountain Coal

Company, near Ashland, Penn'a, being on the south dip of the Mahanoy basin.

"The coal shipped from the colliery came almost exclusively from the Mammoth seam, having a dip ranging from 15° to 60°, and a thickness varying from 25 feet 6 inches to 13 feet 6 inches. The results were:

Length of slope in feet,		780
Length of territory worked,		7,500
Area of territory on dip,		7,195,970
Average thickness of seam,		19′ 5″
Average thickness of coal,		17 0
Percentage of refuse in seam,		12.4
Cubic contents of seam in coal,		122,331,490
Tons of coal, allowing 27 cubic feet to 1 ton,		4,530,796
Adding tons of coal in the portion of Buck Mountain seam worked, *total of coal in ground*,		4,688,436
Tons of coal sent to market,	1,498,807	
Add 5 per cent. consumption at mines,	94,940	
Total coal produced,		1,573,747
Percentage of waste,		66.5
Percentage of coal,		33.5
		100

This colliery has been quite exhaustively worked, and but a very slight quantity of coal can yet be taken from the lifts already worked, and upon which the calculations have been made.

Mr. P. W. Sheafer, of Pottsville, who has had over 30 years of professional experience with the mining of anthracite coal and preparing it for market, makes the total coal reaching market only about one third of the coal in the ground. He says:

The *fearful loss* of good material involved in mining and preparing anthracite, as shown in the accompanying tables, though greatly to be deplored, seems to be almost inevitable. The disposition of the coal in large solid beds, and in highly inclined positions, involves strong supports to keep the superincumbent mass from crushing and closing the avenues to the mines; and these supports must consist of massive pillars of the solid coal itself. Wooden props, however ponderous and strong, can only be used for the minor supports. Some of this pillar coal is ultimately re-

moved, but much of it is inevitably lost, especially in the large beds, which frequently range from 20 to 40 feet in thickness, and are often inclined at an angle of from 40 to 70 degrees.

It is estimated that not more than 66 per cent. of the coal is ever taken out from the mines. That which is brought to the surface is now passed through a huge structure from 80 to 100 feet high, very appropriately called a "breaker," ingeniously contrived for the destruction of coal. There are over 300 of these immense buildings in the anthracite region, costing on an average $50,000 each, or an aggregate of $15,000,000. To the top of these the coal is hoisted and then descends through a succession of rolls and screens, emerging at the bottom, in a series of assorted sizes, from huge blocks of lump coal to the unmerchantable dust, which forms a greviously large proportion of the whole. This process involves a loss of good coal, equal to 20 or 25 per cent. of the entire quantity mined. For the coal wasted in mining, say 40 per cent., and in preparing, 25 per cent. no one is paid; it is a total loss to land owner, miner, and shipper.

Plans for utilizing the waste coal dirt, or culm of anthracite collieries have been frequently suggested, but none have come into general use.

The anthracite fuel company, at Port Ewer, on the Hudson, in 1877, used 90 per cent. coal dust and 10 per cent. fuel pitch, and made 300 tons of fuel per day, consuming over 50,000 tons of culm. The Delaware and Hudson Company also use at their mines 60,000 tons per annum. They now ship all their coal down to pea sizes, and consume the culm in generating steam. If all our coal companies would follow this excellent example it would enable them to sell half a million tons more coal, and burn the same amount of refuse, thus earning or saving half a million dollars per annum, to add to their revenues.

The Philadelphia and Reading Railroad Company has recently introduced a method of burning coal dust in the furnaces of its engines and the plan appears to meet with success."

Those interested in the questions of the utilization of anthracite slack will find the subject discussed, in one of its phases, in Report MM of the Second Geological Survey of Penna., page 382 et seq.

Mr. Gay, Mine Inspector in Schuylkill county, in 1879, considers that 33 per cent. is too high for the proportion of coal actually won from working the Mammoth vein in the Shenandoah-Girardville basins; even 25 per cent. he considers too high.

The facts adduced by him to support these views are as follows:*

"That the accuracy of my statements should be as near correct as it is possible to attain, and that a fair average basis from which to compute waste should be taken, I have selected two collieries in the Shenandoah district, working the Mammoth seam, which seam, in this district, has an average thickness of 35 feet, the angle varying from (45°) forty-five to (60°) sixty degrees.

"These collieries have not been selected as not having been worked as economically as some others, or that the proportion of coal recovered is not equal in proportion to the area of territory worked out. I have no hesitation in stating that both mines have been as skillfully and economically conducted as any of the mines of the district, and are fair criterions to be governed by in the collection of data from which to make calculations of waste. The enormous loss is not confined to any particular colliery, but extends throughout the coal fields, wherever the Mammoth seam is worked.

"The district selected comprises the greater part of the Mahanoy and Shenandoah basins, extending from the Mahanoy tunnel, on the east, to Girardville, on the west, a distance or length of eight miles, and having a mean breadth of two miles, and area of sixteen square miles, or $\frac{1}{29}$ of the total area of the anthracite coal field of Pennsylvania.

"In my calculations I have assumed the thickness of seam at thirty-five feet, deducting therefrom ten feet for

* Report of Inspectors of Mines, Anthracite Regions, 1879, page 21.

refuse, or about $28\frac{5}{10}$ per cent. The thickness of the Mammoth seam, as taken at eight collieries by H. S. Thompson, Esquire, engineer for the Girard estate, is as follows:

	Coal.	*Refuse.*
Lehigh, No. 3,	34′ 10″	5′ 7″
Kehley run, bottom split,	22 7	4 1½
William Penn,	29 4	7 8
Bear Ridge, No. 1,	33 5	5 9
Colorado, bottom split,	24 4	8 6
Colorado, top split,	15 0	2 9
Packer, No. 4,	33 4	8 10
Bear Ridge, No. 2,	22 0	2 10
Hammond, bottom split,	22 8	4 11
Hammond, top split,	16 0	2 7
Average thickness of coal and refuse in seams,	31 10	6 6⅛

The above table gives an average thickness of 31′ 10″ of coal, and 6′ 6⅞″ of refuse, or about 20 per cent.

Stanton Colliery.

Depth of slope in feet,		720
Length of territory under lease, running from east to west,	6,640	
Average run on dip of seam,	600	
Area of territory, in square feet, on dip,		3,984,000
Average thickness of seam,	35	
Cubic contents of seam,		139,440,000
Deducting $28\frac{5}{10}$ per cent. for refuse in seam, leaves,		99,600,000
Tons of coal in seam, allowing 25 cubic feet per ton,		3,984,000
Tons of coal sent to market,	581,413	
Six per cent. added for coal used and sold at mines,	34,884	
Estimated amount of coal to be mined on present level,	75,000	
Total amount recovered, in tons,		691,297
Tons of coal lost in mining and wasted in preparing,		3,292,703

The first shipment of coal from this colliery was made in September, 1871. The coal and refuse are hoisted and dumped into a pony breaker, where the dirt is separated from the coal, and other refuse taken out, so as to leave but a small amount of anything but clean coal to undergo the process of breaking and separating into small sizes.

By the latter process alone the waste is equal to 15 per cent. Mr. Hecksher, of the firm operating Koh-i-nor colliery, estimates the waste in breaking at that colliery for the

year 1879, to be fifteen thousand tons more than it would have been had there been a demand and fair prices for the larger size coal.*

Gilberton Colliery.

Depth of slope in feet,		729
Length of territory under lease, from east to west, in feet,	7,200	
Average run on dip of seam,	700	
Area of territory on dip, in square feet,		5,040,000
Average thickness of seam,	35	
Cubic contents of seam,		176,400,000
Deducting 28 $\frac{5}{10}$ per cent. for refuse in seam, leaves,		126,326,000
Tons of coal in seam, at 25 cubic feet to the ton,		5,053,040
Tons of coal sent to market,	1,127,167	
Six per cent. added for coal used and sold at mines,	67,629	
Estimated amount of coal to be mined on present level,	50,000	
Total amount recovered, in tons,		1,244,796
Total of coal lost in mining and wasted in preparing,		3,808,244

Mr. Chester, the General Superintendent of the Lykens Valley Company, says concerning their mine waste:

"While we have some veins from 8 to 10 feet thick, where the amount left in as loss does not exceed 12 per cent., again we have some veins from 6 to 8 feet thick, with from 5 to 10 feet of slate between two veins of coal, when the loss in mining is from 25 to 30 per cent., and at times the loss is even greater than this where the slate between the veins is very loose and the top to the upper vein is also poor.

The least waste in the mine is in the Lykens Valley vein, or in those lying above it and below the Mammoth vein, and the next in loss is the twin veins in the Shamokin region."

With reference to the total percentage of waste in mining and preparing coal in the Wyoming Valley, Mr. Irving A. Stearns, Mining Engineer, of Wilkes-Barre, measured and computed some worked out areas with the following results:

1. Area 16 acres. Average thickness of vein, four feet six inches (4′ 6″) of coal.

* The above article applies only to the Mammoth Seam.

Of the total amount in the ground, computing at 93.5 pounds per cubic foot or specific gravity of 1.5 for the Baltimore vein—

There was sent to market,	46 per cent.
Left in mine and wasted at breaker,	54 per cent.
	100

2. Area, 63 acres. Coal vein from six to ten feet thick, with from one foot to eighteen inches of bone and slate. Of the total amount in the ground—

There was sent to market,	31 per cent.
Left in pillars and wasted at breaker,	69 per cent.
	100

3. Area, 52 acres. Vein with five feet ten inches (5′ 10″) of coal, no slate—

There was sent to market,	50 per cent.
Left in mine and wasted at breaker,	50 per cent.
	100

4. Area, 20 acres Vein has ten feet eight inches (10′ 8″) of coal; the total thickness of the vein, including slate and bone runs to eleven and twelve feet (12′).

Of the total amount of coal in the ground—

There was sent to market,	45 per cent.
Lost in mine and wasted at breaker,	55 per cent.
	100

5. Area, 10 acres. The vein has an average of seven (7) feet thickness of coal.

Of the total amount of coal in the ground—

There was sent to market,	48 per cent.
Lost in mine and wasted at breaker,	52 per cent.
	100

6. Area, 11 acres. The vein has an average thickness of eight feet six inches (8′ 6″) of coal. Of the total amount of coal in the ground—

There was sent to market,	48.8 per cent.
Lost in mine and wasted at breaker,	51.2 per cent.
	100 per cent.

These percentages of Mr. Stearn's are made from mines

worked a number of years ago, when all of the pea coal, and most of the chestnut also, went on to the dust pile.

To add to these amounts sent to market as given above the amount of chestnut and pea coal which would now be saved at the breaker would raise the shipment percentage by from 7 to 9 per cent., and lower proportionately the percentage of total waste.

These figures of total wastage, while they vary widely from each other, all agree in showing that the waste in mining the Mammoth coal bed in the Shenandoah and Mahanoy basins is unusually great.

The figures of Mr. Gay would show only 17 and 24 per cent. respectively of the total coal in the ground as loaded into the cars for shipment at the collieries taken by him for examples.

The Locust Run colliery measurements show that 33.5 per cent. of the total coal in the ground was shipped to market. This is 40 per cent. more than one of the previously named collieries, and nearly 100 per cent. improvement on the other one.

The figures at the collieries near Lost Creek show that about 30 per cent. of the coal in the ground goes to market; that while they take out between 60 and 62 per cent., yet one half of this is refuse and breaker waste, leaving from 30 to 31 per cent. for shipment.

Mr. Sheafer gives the average of his measurements and examinations to be 33 per cent. of coal in ground reaching market and 67 per cent. lost in mining and breaking.

These figures (except Mr. Sheafer's) all relate only to the Mammoth bed, and only to the Mammoth in this particular basin, where the bed is of unusual size, though carrying interleaved much bone and shelly coal, slate and other refuse matter.

The distribution of this refuse matter affects the loss of coal and lowers the percentage of marketed coal. While the refuse stuff as shown by the section of the whole mass may be only 25 per cent., yet in bringing the mine car to the breaker the wastage will be 50 per cent. or at times even more. Of this wastage 15 per cent. is breaker waste proper,

due to the breaking the coal to sizes, and 35 per cent. remains of refuse as against 25 per cent. shown by the section. Much coal sticks to the slate, and small coal benches interleaved with slate layers are a total loss.

Of the Mammoth coal bed in this region therefore about 30 per cent. is now actually shipped. Even by an improvement in mining which should raise the output to 70+per cent. of the total, while the refuse stuff remains as at present, the total shipped yield would be 35+per cent. of the coal in the ground, and this is naming maximum figures, at this time probably not reached by any colliery working that vein in the Mahanoy and Shenandoah region.

Of the Mammoth coal bed at the Summit Hill mines of the L. C. and N. Co. it was reported that 30 to 35 per cent. reached market. The Mammoth at these mines is 60 feet thick.

But the averages brought out by examination of results at these collieries must be confined to the Mammoth bed of that region.

For in working the Mammoth coal bed in other basins, in the workings on the Buck Mountain, Wharton, Lykens Valley, and the Baltimore bed of the Wyoming valley the wastage is less; many returns show that the percentage of coal actually shipped to market runs up to and over 50 per cent. of the total coal in ground.

This percentage changes with any alterations in the structure of the coal bed with reference to alternations of slate and coal and also to changes in the roof. Mr. Chester states that while in mining an 8 to 10 foot coal they only left 12 per cent. in the ground, yet in mining a somewhat smaller coal 6 to 8 feet thick, but with slate parting and poor roof the actual mine loss ran up to 30 and even 40 per cent.

Mr. Jos. S. Harris has recently reported to the Philadelphia and Reading Railroad Company upon the value of their anthracite coal lands.

In order to reach a valuation it was necessary to use as a factor the acreage, amount of coal in ground and amount of merchantable coal to be realized therefrom.

Mr. Harris' estimate is as follows:

"The subject of the actual contents of coal in the company's lands is one which has been very carefully studied by different persons in the past few years, and a good estimate can now be made of the amount that may be sent to market from the estate. A very elaborate calculation of the coal content was completed in 1876 by Henry Pleasants, the late Chief Engineer of the Company. From data which, in the undeveloped portions of the property, were obtained by thorough explorations by trial shafting, and in that part of the estate where the mines had been worked, from the knowledge gained by mining, a number of geological cross-sections were drawn. Using these cross-sections and the known areas underlaid by the different seams of coal, detailed calculations of content were made with great care, and the highest accuracy attainable; and, as the result of the investigation, Mr. Pleasants reported that the Company's estate contained 4,476,000,000 tons of coal. In July, 1879, I prepared a report on the probable duration of the Pennsylvania anthracite supply, in which, from independent data, I estimated that 1,189,000,000 tons of coal could be shipped from the Reading Company's estate.

Within the past few months the Company's engineers have again investigated the subject, in a new manner, and from data not heretofore used. From the actual shipments of a number of the older colleries they have found how much coal several of the leading veins on the estate can be expected to yield per acre. From this the yield of each of the veins has been deduced, and, knowing the limits underlaid by each vein, the total content of the estate has been readily computed. This estimate gives 1,208,254,000 tons of coal as the amount that the estate should yield. This quantity agrees closely with that reported by me, as quoted above; but as mine was but a good general estimate, and this was derived from a much more careful computation, I have adopted it as being the best attainable result. Comparing it with Mr. Pleasant's estimate of the contents of the lands it gives the result that about 27 per cent. of the coal existing in the lands can be sent to market. There is a reasonable agreement between these estimates of con-

tent and possible shipment, as may be inferred from the experience of the Lehigh Coal and Navigation Company, which Company has for sixty years mined in the territory east of the limits of and adjoining the Schuylkill district. From an area which is computed to have originally contained 52,266,000 tons of coal, that Company has shipped 18,100,000 tons, or $34\frac{6}{10}$ per cent.; and it is estimated that when the coal within that area shall be entirely exhausted, the shipment will have been 20,240,000 tons, or $38\frac{7}{10}$ per cent. of the original contents. This unusually favorable result has been made possible by the coal being mined at comparatively small depths, and at considerable inclinations,—the latter cause much increasing the yield per acre,—and by its having been very thoroughly worked. Taking into consideration the differing circumstances, it is a fair inference that 27 per cent. represents well the proportion between shipment and content on the whole of the Reading Company's estate."

In determining the average percentage of waste in mining, the different coal basins must be taken separately; again different coal beds in the same region must be considered separately; and again the same coal bed in different parts of the same region must be considered separately.

The Lykens Valley coal bed probably puts one half of its total coal in ground into cars for shipment; the Mammoth coal bed at Shamokin and Mount Carmel puts perhaps 40 per cent. on the cars for shipment; while the Mammoth going eastward through Ashland, Girardville and Mahanoy puts not much over 30 per cent. on the cars.

In estimating the future yield of the deep basins we must presume that there will be found much crumpling and folding of the bottoms of the deep basins, spoiling much coal; the mine waste will be heavy on account of the enormous burden to support; and the lifts will be great. In view of many circumstances it would hardly be safe to take the probable yield of all the coal beds in the deep basin at over 30 to 33 per cent. of the total coal in the ground.

These deep basins, of the Schuylkill region, hold the future reserve of the anthracite coal supply. The Lehigh

region has probably reached, or nearly so, its maximum of production; the Wyoming and Lackawanna regions are diligently worked by six great companies, and though they have much coal left, yet their coal land has become very costly and the coal will be more carefully guarded by the companies; and the deep basins of the Schuylkill region will be of the greatest value in the future.

In the Lehigh region the coal is hard, the roof firm and good; and certainly in one case, on the Buck mountain bed, over extensive workings, more than one half of all the coal in the ground has gone to market. Probably there are other cases where nearly one half or fully that has been marketed.

The Mammoth bed in the Lehigh region also yields a large percentage of marketed coal, but not quite so much as the Buck mountain bed. In this case it must be remembered that the coal is largely shipped in large sizes.

In the Wyoming and Lackawanna region, in working the Baltimore bed, probably some 50 per cent. of the total coal goes to market, though much of it has to be broken down to stove and smaller sizes. Indeed on the horizontal workings of the Lackawanna basin somewhat more than this percentage reaches market.

It would be useless in this preliminary report to touch upon the questions involved in changes in the system of mining, by which savings in waste can be made. In Europe they also mine large coal beds, on steep pitches, and yet they have effected many reductions in mine waste. It would require a full discussion of these methods, taken in each case in connection with the value of labor and value of coal in the ground, to make any application of them to the mining of coal in our anthracite fields, separating out the items of timber involved and cost of labor. For with us labor is likely to remain a costly item, while the actual value of coal in the ground, comparing surface prices per acre, is much less with us than with the coal fields of England or the continent of Europe.

All this will be discussed in a future volume of the Survey reports.

Chapter V.

Waste in breaking anthracite coal—Second basin—Mahanoy to Trevorton.

The preceding chapters have shown how the coal lies in the ground, how it is mined, how prepared, and approximately how much is left behind in the mine in the shape of pillars.

Of the actual out-put of coal from the mine there is, therefore, no record so far, save the number of mine cars hoisted, some of coal and slate intermingled, and some of rock.

Now as all the large slate and the dust made in mining are taken out at the top of the breaker, and the balance, which is the coal with some slate sticking to it, is passed through the breaker to be broken into sizes, the breaker itself has hitherto been charged by persons not well acquainted with coal preparation, with entirely too large a share of the total wastage; that is, sufficient account has not been taken of the enormous amount of refuse matter in the shape of slate, dirt made in mining, poor or shelly coal, slate fall from roof, &c., which comes out in the mine cars on steep pitching coal beds.

In the subdivision of the items of wastage at the close of the detail of each colliery, due effect must be given to the dip of the vein, its size, &c., &c., and the wastage is distributed thereby.

Moreover, account must be taken of the coal used at mines under boilers, &c., amounting to some 4 per cent.; the coal sold to employés; and the coal lost in getting from the colliery to the weigh scales.

It will be noticed in the computations that the product of shipped coal and weighed dust exceeds at most collieries the computed mine product, as taken from number of cubic feet of mine cars, and weight of lump coal per cubic foot.

It is right that it should exceed the theoretical yield.

For a mine car of 150 cubic feet loaded with coal at 60 pounds to the cubic foot is 9000 pounds; while 150 cubic feet of solid coal are 15,000 pounds; that is, the interstitial spaces in that car represent 6000 pounds of solid coal, or 60×60=3600 pounds of coal in sizes of lump or from that down to dust. In loading the mine car much dust comes into the car, fills these interstitial spaces, and increases the weight in a varying proportion, though the mine car is never more than level full.

In order to secure exact figures at the Shenandoah collieries of the Philadelphia Coal Company, and thus work out a proper subdivision of the total wastage, Col. Brown made the following tests:

"The first trial was with 6 tons of coal that passed through the steamboat coal bars, which latter are 3½ inches apart. This coal represents the condition of the coal that usually goes into the broken, egg, stove, and smaller coals. We screened all the dirt from it before putting it on the scales.

The coal was broken down to egg and stove sizes in proportion of 1 egg to 2 stove.

The trial gave 15.84 per cent. of waste through $\frac{7}{16}''$ mesh; 2129 pounds of waste, of which there were 1077 pounds of buckwheat size, and 1052 pounds dirt through $\frac{1}{4}''$ mesh.

The second trial was with 6 tons of hand-picked, large sized steamboat coal, in pieces weighing from 3 to 15 pounds. This coal was passed through the rollers, breaking it down to the same size as the first trial, but showing a larger proportion of egg.

The 6 tons made a waste ($\frac{7}{16}$ inch mesh) of 1974 pounds, of which there was of Buckwheat coal (screened over $\frac{1}{4}$ inch mesh) 899 ponnds; 1974—898=1076 pounds of coal dust. The percentages therefore were

Dust waste,	8 per cent.
Buckwheat waste,	6.7 "
	14.7 "

It is not surprising that the second trial showed somewhat less waste than the first, inasmuch as steamboat coal

is the strongest coal, having withstood the shocks of handling and preparing for market, making rather more dust but less buckwheat size, which latter we also regard as waste. The results are—

First trial, 6 tons, taken from *under* steamboat coal bars, gives	15.84 per cent.
Second trial, 6 tons, taken from *over* steamboat coal bars, gives	14.7
	2)30.54
An average of	15.27

This experiment gives the actual loss in breaking and screening clean steamboat coal down to egg and stove sizes, the coal coming from the Mammoth bed, in the Shenandoah region.

In the third experiment 2,000 pounds of clean coal, of the same kind used in the first experiment, were carefully broken down to egg and stove sizes by hand, in the old-fashioned way, using hammers weighing about 1½ pounds.

The broken coal was screened by hand sieves of scant half inch mesh, old-fashioned half inch.

The waste,	125½ lbs. =	6.28 per cent.
Coal,	1,874½ lbs. =	93.72 "
	2,000	100

This coal, after weighing, was put through the elevators and hoisted up to the regular breaker screen, same as used in previous experiments.

The waste from screening weighed 80 pounds. Equal *to 4 per cent.* of the coal.

This shows that breaking and screening by hand wasted	6.28 per cent.
Breaking by hand and through circular screens, wasted	10.28 "
Breaking through rollers and screening in the present way, wasted	15.27 "

We also observed that the weight per cubic foot of coal and refuse, as coming from mines, measured in car before unloading, weighed 73⅛ pounds per cubic foot; that refuse, as loaded at breaker, weighed but 67½ pounds; fine dust refuse, 59⅛ pounds, &c.

Lump and small coal mixed weighed 65 pounds per cubic foot, separate they weighed 60 pounds; steamer size, 58 to 60 pounds; broken and egg, 56 to 58 pounds; stove, 55 to 56 pounds; chestnut, 54 pounds; pea, 53 pounds; buckwheat, 52 to 53 pounds to the cubic foot.

The mine cars are loaded with rounding top, and when first loaded would measure more cubic feet; but the measure of wagons was made outside, after the coal settled down in the cars, and this accounts for the greater weight per cubic foot as measured. Yet this is a condition that holds good in all coal and refuse measured in cars outside of mine.

The colliery where these trials were made is a fair representative of the white ash collieries in this region (Lost Creek).

Another colliery in the Shenandoah region, working the Mammoth bed, and furnishing a fine hard coal as their product, made the following measurements and tests of the percentage of breaker waste. They report the results thus:

"On March 4, 1879, we broke 700 pounds of steamer coal through two setts of rolls, good sharp teeth—chilled points—with the following result:

461 lbs.	Broken,	32.93 per cent.
214 "	Egg,	15.29 "
164 "	Large Stove,	11.71 "
115 "	Small Stove,	8.21 "
104 "	Chestnut,	7.43 "
62 "	Pea,	4.43 "
280 "	Waste,	20 "
1400 lbs.		100 "

The mesh over which the pea coal was passed has most of the spaces $\frac{5}{8}$ of an inch square, some of them were $\frac{1}{2}$ an inch square.

This trial gives *20 per cent.* of waste (dust and Buckwheat coal) in breaking down lump and steamer to smaller sizes.

At the same colliery on Feb. 4, 1877, they broke 500 lbs. broken coal through monkey rolls, with steel pointed teeth and obtained—

Large Stove,	81	pounds.	
Small Stove,	186	"	
Chestnut,	88	"	
Pea,	17½	"	Pea coal mesh ⅜ inch square.
Waste,	127½	"	
	500	"	

In this case the waste, including in that both dust and Buckwheat coal, was *25½ per cent.*

On the same day at the same colliery they broke 500 pounds of Egg coal, with the following results:

Large Stove,	120	pounds.	
Small Stove,	209	"	
Chestnut,	81	"	
Pea,	18	"	Pea coal mesh ⅜ inch square.
Waste,	72	"	
	500	"	

In this case the waste was only 14.4 per cent.

The coal in each case was screened through regular circular breaker screens.

The close agreement of the latter test with the tests made by Col. Brown would indicate that somewhere about 15 to 16 per cent., or a little over, is the breaker waste for the Mammoth coal in the Shenandoah region.

To show just where the wastage goes, and into what subdivision the waste percentage properly falls, four collieries in the Shenandoah region are given in full detail.

It would be neither possible nor desirable to continue such complete detail in the case of every colliery considered; but after these cases are so fully stated it will be possible for any reader to apply the general averages to any desired colliery described in this volume.

For in every case there is given the name of the coal bed worked, its size, and dip; by applying these the proper mine waste can be estimated and then the breaker waste computed, not indeed exactly, but within reasonable limit of error.

It must be remembered that what is called dust in these figures includes the slate picked by hand by boys at the breaker, and that the hand picked slate is at times as much as 3 or 4 per cent. of the total dust amount.

In order to make use of the colliery figures with exactness Col. Brown, the General Manager of the collieries of the Philadelphia Coal Company, procured the following data.

An average car of coal as it comes from the mine, and containing 132 cubic feet, was screened over a ½ inch mesh, the refuse and slate picked out and weighed. This car represents an average of the Mammoth vein, 30 feet in thickness.

The following are the results:

Marketable coal of all sizes,	5,737 lbs.
Refuse coal, bone, and slate,	2,358
Dirt, waste by mining, and soft seams of coal and dirt,	1,557
Total,	9,652

This gives the percentage of coal coming from the mine, in the mine car, to be 59.4 per cent.; and the dirt and refuse matter is 40.6. This is of course on a steep pitching coal bed.

The breaker experiment showed that 15 per cent. was the proper percentage to take for breaker waste, 11 per cent. for breaker and 4 for screening, 15 in all. Deducting this percentage from the coal raised and adding it to the dirt and refuse gives the yield in the cars, thus:

	Per cent.
Coal,	59.4—(15 % of 59.4)=50.5
Waste,	40.6+(15 % of 59.4)=49.5
	100.0 100.0

The above 50.5 per cent. coal and 49.5 refuse is the percentage for coal cars hoisted from mine; to get the proper percentage of the *mine product* an allowance must be made for the rock hoisted.

The rock hoisted for one year shows to be 8.6 of the coal. 8 6 per cent. of 50.5 is 4.3; this added to the 49.5 and deducted from the 50.5 gives *46.2* per cent. for marketable coal and *53.8* per cent. for refuse and dirt, taking in this case the whole mine product.

From this experiment the following facts were determined:

Coal in cars, as it comes from the mines, weighs,	73⅛ lbs.
Refuse,	67⅔ lbs.
Dirt,	59⅛ lbs.

Col. Brown says:

"I thus estimate the waste in mining, breaking, screening, and loading coal into cars, assuming that the coal has been freed from all refuse matter such as slate, bone coal and fine dirt due to the soft shaly slips in veins and between the benches of coal:

1. Waste in mine:

Cutting coal, blasting, &c., ...	10	per cent.

2. Waste at breaker:

Breaker rollers, ...	11.27	"
" screening, . . .	4.00	"
Loading over lip screens from shutes into cars, .	2.00	"
	27.27	"

To this may be added about 2½ per cent. for leakage of coal in loading, transportation and unloading into yard or bin.

The waste in transportation is in my opinion very small and does not exceed 1 per cent.; the dirt waste found in cars at point of delivery is largely due to breakage of coal when loading from shute at breaker.'

It was well known that the improvements in the apparatus for breaking coal have resulted in considerable saving of coal.

Mr. Jos. S. Harris, the Engineer of the Lehigh and Wilkes Barre Coal Company, had some experiments made at the collieries of the company which determined this percentage accurately. The record is one of great value as showing just what has been gained by changing the apparatus. Mr. Harris says:

"With this I send you the promised report of the experiments made at Wilkes Barre, which may be useful to you as showing the result of the use of the present style of apparatus for breaking anthracite coal into sizes.

There are two sizes of rolls used in the Wilkes Barre region, the larger, through which the coal passes first being similar to those called "steamboat rolls" in the Schuylkill region, and known in the Wilkes Barre region as "crushers." The second set of rolls is known alike in the two regions as "prepared coal rolls."

The rolls called in the statement "old style" have cast-iron teeth and are similar to those now in general use in the Schuylkill region; the "new style" have movable steel teeth inserted in a cast-iron body. You will notice that the waste is much less with the new rolls.

The complete tables, which are given in full in Chap. VII relating to the Wyoming Valley, give the following general averages:

1. Diamond Breaker. Baltimore vein.
   Improved Standard steel tooth crushers. Loss, . $11\frac{88}{100}$ per cent.
2. Empire Breaker. Baltimore vein.
   Old style crushers. Loss, ... $11\frac{96}{100}$ "
   New style. Loss, ... $8\frac{03}{100}$ "
3. Empire Breaker. Hillman vein.
   Old style crushers, ... $17\frac{68}{100}$ "
   New style crushers, ... $11\frac{96}{100}$ "
4. Ashly No. 6 Breaker.
   Baltimore vein, ... $11\frac{56}{100}$ "
   Ross vein, ... $10\frac{93}{100}$ "
   Red Ash vein, ... $5\frac{88}{100}$ "
5. Sugar Notch No. 10 Breaker.
   Old style rolls, ... $18\frac{75}{100}$ "
   New style rolls, ... $13\frac{15}{100}$ "
6. Lance No. 11 Breaker.
   Old style crusher, prepared rolls, ... $15\frac{30}{112}$ "
6. Nottingham No. 15 Breaker.
   Old style rolls, ... $12\frac{36}{112}$ "
7. Reynolds, No. 16 Breaker.
   Old style prepared rolls, ... $17\frac{6}{112}$ "

That is—there is a direct saving in breaker waste of from 3 to $5\frac{1}{2}$ per cent. by the improved breaker apparatus. This reduction brings down the breaker waste, in working the Baltimore vein, with steel tooth crushers to a percentage ranging from 11 to 13 per cent. or an average of 12 per cent. And this is all that the breaker is to be held accountable for.

In almost all writings concerning the anthracite regions the breaker loss is considered a deplorable though necessary evil. I have already quoted in this chapter the results

of investigations which showed that the breaking and screening by hand, in the old-fashioned way, lost 6.28 per cent.: by the present breaker and screens 15.27 per cent.: and that the breaker is to be held chargable with an extra loss over the old style of 9.00 per cent.

This is, of course, where all the Chestnut and Pea coals are marketed and only the buckwheat coal and dust go to the waste dump.

In arranging the collieries to show the detail of waste the following order has been preserved:

Second basin, Chap. V.
1. Collieries on hard white ash coal, in the Mahanoy-Shenandoah basin.
2. Free burning white ash coals in the Mount Carmel region, westward continuation of No. 1.
3. Shamokin coal in same great basin—still further west.
4. Trevorton coal west of Shamokin.

First basin Chap. VI.
1. Free burning white ash coals in First basin, starting from east and going westward.
2. Red ash and Red and white ash coals.
3. Lykens Valley coal.

Chap. VII.
- Lehigh Region.
- Wyoming Region.
- Lackawanna region.

In sub-division 1, the hard white ash collieries, the breaker waste is taken as the same at all the collieries, shipping the same sizes, varying constantly at all of them directly as they ship more or less of the large sizes, or as they save or lose the whole or a part of their pea coal.

In collieries Nos. 1 to 5, the total waste percentage is subdivided into its component factors, taking the whole mine output, rock and coal included.

In all the collieries following, only the coal and dirt are included, taking in with the dirt, in all cases, the hand picked slate at the breaker, which is hauled away with the dirt, and which averages 3 or 4 per cent. at most of the collieries.

With the figures given for these collieries, and the description of waste in blasting, in the pages just preceding this, it is possible for any one to work out the problem of each colliery for himself, keeping the breaker waste the same (for the same sizes of coal) for all the 15 hard white ash collieries.

1. Hard White Ash Coals.

Colliery No. 1, Colorado.

This colliery works the Mammoth coal bed. The bed is very large at this place, but contains many layers of slate. These add to the wastage, as much coal will stick to the slate and is thrown away with it.

Two sections of the Mammoth at this colliery will serve to show how the coal and slate are interleaved as well as to show how the coal bed itself changes in thickness.

One measurement shows:

Coal,	0′	9″
Refuse (slate and bone),	0	2
Coal,	3	0
Refuse,	1	4
Coal,	2	0
Refuse,	1	2
Coal,	3	0
Refuse,	0	9
Coal,	3	0
Refuse,	0	4
Coal,	2	0
Refuse,	0	6
Coal,	0	10
Refuse,	0	6
Coal,	6	0
Refuse,	1	2
Coal,	2	0
Refuse,	0	8
Coal,	1	6
Refuse,	0	1
Coal,	0	8
Refuse,	1	0
Total,	32′	10′

Of this, 24′ 4″ are coal and 8′ 6″ are refuse.

Another section in the same colliery shows:

Refuse,	0′	6″
Coal,	4	6
Refuse,	0	6
Coal,	2	0
Refuse,	0	1
Coal,	11	0
Refuse,	1	0
Coal,	2	0
Refuse,	0	5
Coal,	2	6
Refuse,	0	3
Total,	17′	9″

Of this, 15 feet are coal and 2′ 9″ are refuse.

In working on the steep pitch this refuse necessarily comes out with the coal in the mine cars.

The breaker records show:

	Tons.	
Coal hoisted and passed through breaker,	187,541	
Rock hoisted,	1,877	
		189,418
Rock dumped,	20,758	
Dirt and slate dumped,	70,796	
Boiler coal,	5,235	
Coal shipped,	89,780	
Rock as above,	1,877	
		188,446
Difference,		972

	Tons.	
Thus giving coal,	95,015	or 50.4 per cent.
Refuse,	93,431	or 49.6 "

This wastage of 49.6 per cent. may be thus subdivided into its proper items:

Rock refuse,	12.
Breaking, Screening, 59.4×15.5,	9.30
Slate picked at breaker,	4.00
Loading over lip screen, 2×59.4,	1.2
Going to weigh scales,	1.0
Blasting (10) and refuse,	22.1
	49.6 per cent.

The yield of the Colorado Colliery for 12 months shows thus:

	Cars.	
Lump,	2575	
Steamboat,	3173	
Broken,	2094	
Egg,	2482	
Stove,	2578	
Small stove,	607	
Chestnut,	1434	
Pea,	848	
Total,		15791
Amount shipped in tons,		89780
Boiler coal,		5235
Total,		95015

Colliery No. 2, Shenandoah.

This colliery is on the northeast end of the same tract as the Colorado. The Mammoth coal bed is worked on the south dip. "The average thickness of the vein when the top and bottom members are together is about 38 feet, of which we mine about 30 feet, and occasionally get down the top to slate. A portion of this mine is wrought on the 'Panel system' and we estimate that we take out very nearly three fourths of the vein so far as we have exhausted the mine.

The deep levels of this mine show the vein split, which we denominate as the top and bottom members."

A section of the Mammoth in the lower workings, showing the split and the amount of rough coal and refuse to come out, is as follows:

Top slate,			—
Coal,	5′	8″	13′ 8″
Slate,	1	0	
Coal,	2	0	
Bony coal and slate,	0	8	
Coal,	1	0	
Bony coal and slate,	0	4	
Coal,	3	0	
Fine hard sandstone,	11	8	
Slate,	13	2	
Rough coal,	0	5	21′ 5″
Coal,	2	9	
Rough coal,	0	3	
Coal,	2	6	
Bony coal,	0	6	
Hard slate,	0	6	
Coal,	2	0	
Slate,	0	1	
Coal,	4	6	
Bone and slate,	0	9	
Hard slate,	0	5	
Coal,	2	6	
Slate,	0	5	
Coal,	1	0	
Rough coal,	0	3	
Coal,	2	7	

In working on the steep pitch the bony coal and slate come out in the mine cars.

The breaker record shows:

	Tons.	
Coal hoisted and passed through breaker,	257,320	
Rock hoisted,	11,231	
		268,551
Rock dumped,	24,895	
Dirt and slate dumped,	39,090	
Dirt dumped,	23,039	
Boiler coal,	6,919	
Coal shipped,	136,248	
Dirt washed from counter screen,	27,129	
Rock as above,	11,231	
		268,551

Or

Coal,	143,167 tons, or	53.3 per cent,
Waste,	125,384 "	46.7 "

The shipments of coal from the colliery for 12 months were of the following sizes:

	Cars.
Lump,	3909
Steamboat,	2410
Broken,	3434
Egg,	2508
Stove,	2237
Small stove,	1579
Chestnut,	4251
Pea,	3338
	23,666

Making a shipment in all of 136,248 tons.

The wastage of 46.7 per cent. may be subdivided thus:

Rock refuse,	13.5
Breaking, Screening, } 15.5×63,	9.8
Slate picked at breaker,	4.0
Loading over lip screen 2×60,	1.2
Going to weigh scales,	1.0
Blasting and refuse,	17.2
	46.7

Colliery No. 3, Lehigh.

This colliery is in the same region as the Colorado and Shenandoah.

"It is on the Mammoth vein, south dip, varying from 50° near surface down to basin where it flattens off to 12°, and abruptly turns up forming an inverted north dip.

The coal mined during the period covered by the statement of operations was taken principally from the top benches

of the vein at the first and second lifts, where nearly all of the bottom benches had been taken out in 1876, 1877 and the earlier part of 1878. This accounts for the large percentage of refuse, and without making very accurate calculations I find that the average of four years' operations give about the same results as at No. 2 and No. 4 collieries.

The bed at some points is very large. I have measured it as much as 60 feet thick. The usual thickness is about 40 feet, of which about 25 per cent. are slate and bony coal."

The breaker record shows thus:

	Tons.	
Coal hoisted, and passed through breaker,	180,042	
Rock hoisted,	16,918	
		196,960
Dirt and slate dumped,	68,072	
Large slate and refuse,	12,151	
Coal shipped,	85,017	
Boiler coal,	4,727	
Coal used for employés,	1,194	
Dirt washed away,	8,881	
Rock as above,	16,918	
		196,960

Or

Coal,	90,938 is 46.2	per cent.
Waste,	106,022 is 53.8	"
	100.0	"

"Referring to the estimated quantities of refuse and total out put of mine, there is an item of 8881 tons as washed away. This is the sum necessary to balance, but it is probably two or three thousand tons below the actual amount washed away. This difference can be accounted for by the account of dirt dumpers, and the average load being over estimated."

The coal shipped from Lehigh Colliery was of the following sizes:

	Cars.
Lump,	2440
Steamboat,	1317
Broken,	1249
Egg,	3054
Stove,	1846
Small stove,	1330
Chestnut,	2725
Pea,	1068
	15,029

Making a total of 85,017 tons shipped.

The 53.8 per cent. of waste subdivides thus:

Rock refuse,	14.7
Breaking, Screening, 15.5×55,	8 5
Slate picked at breaker,	4.0
Loading over lip screen, 2×55,	1.1
Going to weigh scales,	1.0
Blasting and refuse,	24.5
	53.8

Colliery No. 4, Packer.

This colliery is also on the Mammoth bed, and by tunnel south cuts a small bed at forty yards 5 feet thick; and at 108 yards cuts the Holmes or Primrose 8 feet 3 inches thick.

However all but a few tons of the coal mined during the period covered by the statement was taken from the Mammoth bed.

This bed varies from 30 to 44 feet in thickness.

The coal has numerous slate partings, thus:

Coal,	4′	0″
Refuse,	0	11
Coal,	2	6
Refuse,	1	0
Coal,	1	7
Refuse,	0	2
Coal,	1	2
Refuse,	2	4
Coal,	1	7
Refuse,	0	4
Coal,	3	1
Refuse,	1	3
Coal,	3	0
Refuse,	1	3
Coal,	6	5
Refuse,	1	3
Coal,	0	5
Refuse,	0	2
Coal,	5	2
Refuse,	0	1½
Coal,	3	9
Refuse,	0	1
Coal,	0	10
Total,	42	4½

Of which 33′ 6″ are coal and 8′ 10½″ are refuse matter, or just about 20 per cent. of the whole bed.

The breaker record shows:

Coal hoisted and passed through breaker,	363,123	
Rock hoisted,	20,368	
		383,491
Dirt dumped,	53,733	
Slate dumped,	66,105	
Jig dirt and slate,	22,101	
Coal shipped,	194,860	
Boiler coal,	6,278	
Dirt washing,	20,046	
Rock as above,	20,368	
		383,491

Or

Coal,	201,138 tons is	52.4 per cent.
Waste,	182,353 tons is	47.6 "
		100

The calculations for this colliery came out more satisfactorily than any of the other collieries, owing to the greater care in keeping correct list of dumpers of refuse and more regular loading in the mine.

The shipments from Packer Colliery, for 12 months, were of the following sizes:

	Cars.
Lump,	3660
Steamboat,	1662
Broken,	7195
Egg,	3899
Stove,	8936
Chestnut,	6390
Pea,	2648
	34,390

or a shipment of 194,860 tons.

The percentage of waste, 47.6, sub-divides thus:

Rock refuse,	13.5
Breaking, Screening, 15.5×62,	9.6
Slate picked at breaker,	4.0
Loading over lip screen, 2×60,	1.2
Going to weigh scales,	1.0
Blasting and refuse,	18.3
	47.6

These collieries, No. 1, 2, 3, and 4, produced during the year as follows:

	Shipments.	*Boiler coal.*	*Total.*
No. 1,	89,781	+ 5,235 =	95,016
2,	136,248	+ 6,919 =	143,167
3,	85,017	+ 5,639 =	90,656
4,	194,860	+ 6,278 =	201,138
			529,977

The coal consumed under boilers is 4.54 per cent. of coal produced, and 4.75 per cent. on total shipments. As the product was materially restricted during the period included in the statement, the coal used for steam purposes bears a larger ratio to production than when the product is not under restriction by short time, &c. During the year 1879 coal consumed under boilers was nearly 4 per cent.

Mr. Brown says that "from the experiments made regarding waste at breaker, and the marketable coal in the vein, I find the average shipment about 53 per cent. of the total out-put; refuse and waste in mining, 32 per cent.; waste in breaking and screening, 15 per cent., and waste in screening over *lip screens* into cars, 2 per cent.

For the totals of a shipment of 600,000 tons from four collieries, mining exclusively Mammoth coal, and on pitches varying from 18° to 70°, these figures are the average of the whole.

Colliery No. 5, Continental.

This colliery works the Mammoth coal bed, with an average thickness of 24 feet.

The bed dips 45°.

The Superintendent, Mr. Lewis A. Riley, had a careful record kept at the colliery for the 4 months ending October 31, 1880. This record shows:

Coal hoisted and passed through breaker,	79,902	
Rock hoisted,	299	
		80,201
Rock dumped,	4,818	
Slate,	11,219	
Dirt,	13,994	
Dirt washed,	14,741	
Boiler coal,	938	
(50% of which is coal,)	938	
Coal shipped,	33,254	
Rock as above,	299	
		80,201

Coal,	34,192 tons or 42.6 per cent.
Refuse,	46,009 tons or 57.4 "

This total of 57.4 per cent. of wastage may be subdivided thus:

Rock refuse,	20
Breaking and screening (15.5×50),	7.8
Slate picked at breaker,	4.0
Loading over lip screen (2×50),	1.0
Going to weigh scales,	1.0
Blasting and refuse,	24.6
	57.4

In these five collieries, the Colorado, Shenandoah, Lehigh, Packer and Continental the ratios of percentage are made out for the total mine product, including all rock and refuse matter. This makes the waste percentage higher and the coal percentage lower than where only coal and waste, excluding rock, have been considered.

In all the collieries, starting with No. 6, only the coal and waste are considered, no attention being given to rock except such slate and refuse as go to the dirt dump. The hand picked slate at the breaker goes out with the dust.

Colliery No. 6, North Mahanoy.

This colliery works the beds below the Mammoth, the three beds yielding respectively 6 feet, 4 feet, and 8 feet of coal or 18 feet in all, worked separately.

The coal beds dip 25°.

The breaker record shows thus:

1. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2284	
Egg and Stove,	4590	
Chestnut and Pea,	2662	
	9536	Per cent. shipped, 65
Dust in tons,	5052	" wasted, 35

2. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	4477	
Egg and Stove,	4959	
Chestnut and Pea,	3240	
	12,706	Per cent. shipped, 67
Dust in tons,	6,386	" wasted, 33

3.	*Shipped.*	*Tons.*	
	Lump, S. Boat and Broken,	2559	
	Egg and Stove,	2430	
	Chestnut and Pea,	1766	
		6755	Per cent. shipped, 65
	Dust in tons,	3514	" wasted, 35

4.	*Shipped.*	*Tons.*	
	Lump, S. Boat and Broken,	2970	
	Egg and Stove,	2063	
	Chestnut and Pea,	1490	
		6523	Per cent. shipped, 66
	Dust in tons,	3342	" wasted, 34

5.	*Shipped.*	*Tons.*	
	Lump, S. Boat and Broken,	3262	
	Egg and Stove,	2203	
	Chestnut and Pea,	1625	
		7090	Per cent. shipped, 66
	Dust in tons,	3603	" wasted, 34

6.	*Shipped.*	*Tons.*	
	Lump, S. Boat and Broken,	3353	
	Egg and Stove,	2295	
	Chestnut and Pea,	1642	
		7290	Per cent. shipped, 66
	Dust in tons,	3708	" wasted, 34

7.	*Shipped.*	*Tons.*	
	Lump, S. Boat and Broken,	2543	
	Egg and Stove,	1534	
	Chestnut and Pea,	1026	
		5103	Per cent. shipped, 65
	Dust in tons,	1696	" wasted, 35

8.	*Shipped.*	*Tons.*	
	Lump, S. Boat and Broken,	2938	
	Egg and Stove,	3056	
	Chestnut and Pea,	1782	
		7776	Per cent. shipped, 62
	Dust in tons,	4793	" wasted, 38

9.	*Shipped.*	*Tons.*	
	Lump, S. boat and broken,	3510	
	Egg and Stove,	3785	
	Chestnut and Pea,	2263	
		9558	Per cent. shipped, 63
	Dust in tons,	5604	" wasted, 37

10.	*Shipped.*	*Tons.*	
	Lump, S. Boat and broken,	4639	
	Egg and Stove,	3931	
	Chestnut and Pea,	2575	
		11,145	Per cent shipped, 66
	Dust in tons,	5,729	" wasted, 34

Mined.	*Shipped.*	*Dust.*	*Rock.*
11,477	9,536	5,052	89
15,035	12,706	6,386	56
8,266	6,755	3,514	37
8,257	6,523	3,342	32
9,353	7,090	3,603	42
9,107	7,290	3,708	71
6,717	5,103	2,696	101
10,262	7,776	4,793	49
11,028	9,558	5,604	224
14,462	11,145	5,729	432
103,964	83,302	44,427	1,133
	44,427		
	1,133		
	128,862		

128,862
103,964

23,898 tons, excess of product over computed coal production by mine car.

The monthly percentage of excess ran thus: 27.9, 27.3, 23.4, 19.8, 14.7, 21.5, 17.5, 23.1, 39.5 and 19.6.

The total product was 127,629 tons of which 65.8 per cent. went into cars for shipment to market and 34.2 per cent. went into the dirt heap.

The monthly percentages of waste ran thus: 35, 33, 35, 34, 34, 34, 35, 38, 37, 34, an average of 34.2 per cent. of waste, as above.

The wastage, 34.2 per cent., may be thus subdivided:

Breaking and screening, 77×15.5,	12.00
Slate picked at breaker,	4.00
Boiler coal,	3.00
Loading over lip screen, 77×2,	1.50
Going to weigh scales,	1.00
Blasting and refuse,	12.70
	34.20

It will be remembered that this, and succeeding collieries, have only reference to percentages of actual coal shipped and coal dust (including slate picked at breaker.)

Colliery No. 7, Mahanoy City.

This colliery works one bench of the Mammoth coal bed 15 feet thick, and also the Holmes' coal bed, 8 feet thick. The coal beds dip 25°.

The breaker returns show as follows:

1. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	4698	
Egg and Stove,	2327	
Chestnut and Pea,	1879	
	8904	Per cent. shipped, 67
Dust in tons,	4458	" wasted, 33

2. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	5654	
Egg and Stove,	3477	
Chestnut and Pea,	2673	
	11,804	Per cent. shipped, 67
Dust in tons,	5877	" wasted, 33

3. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	4012	
Egg and Stove,	1992	
Chestnut and Pea,	1604	
	7608	Per cent. shipped, 70
Dust in tons,	3212	" wasted, 30

4. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3056	
Egg and Stove,	1647	
Chestnut and Pea,	1339	
	6042	Per cent. shipped, 69
Dust in tons,	2740	" wasted, 31

5. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3899	
Egg and Stove,	1944	
Chestnut and Pea,	1490	
	7333	Per cent. shipped, 71
Dust in tons,	2951	" wasted, 29

6. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3521	
Egg and Stove,	1647	
Chestnut and Pea,	1404	
	6571	Per cent. shipped, 71
Dust in tons,	2691	" wasted, 29

7. *Shipped.*	*Tons.*	
Lump, S. Boat, and Broken,	4271	
Egg and Stove,	2009	
Chestnut and Pea,	1463	
	7743	Per cent. shipped, 69
Dust in tons,	3412	" wasted, 31

8. *Shipped.*	*Tons.*	
Lump, S. Boat, and Broken,	4277	
Egg and Stove,	1555	
Chestnut and Pea,	1323	
	7155	Per cent. shipped, 69
Dust in tons,	3187	" wasted, 31

9. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3985	
Egg and Stove,	1598	
Chestnut and Pea,	907	
	6490	Per cent. shipped, 65
Dust in tons,	3488	" wasted, 35

10. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	4342	
Egg and Stove,	1803	
Chestnut and Pea,	1112	
	7257	Per cent. shipped, 65
Dust in tons,	3905	" wasted, 35

11. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	4925	
Egg and Stove,	2214	
Chestnut and Pea,	1009	
	8148	Per cent. shipped, 61
Dust in tons,	5105	" wasted, 39

12. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	6285	
Egg and Stove,	2819	
Chestnut and Pea,	1377	
	10,481	Per cent. shipped, 62
Dust in tons,	6340	" wasted, 38

Mined.	*Shipped.*	*Dust.*	*Rock.*
11,122	8,904	4,458	466
14,632	11,804	5,877	559
9,222	7,608	3,212	363
7,600	6,042	2,740	301
9,052	7,332	2,951	370
7,570	6,571	2,691	310
10,012	7,743	3,412	422

Mined.	*Shipped.*	*Dust,*	*Rock.*
9,357	7,155	3,187	408
9,112	6,490	3,488	407
10,042	7,257	3,905	465
11,535	8,148	5,105	487
14,322	10,481	6,340	662
123,578	95,535	47,366	5,220
	47,366		
	5,220		
	148,121		

148,121
123,578

24,543 tons, excess of actual product over computed product taken from mine cars, or 20 per cent. excess.

This excess varies by months thus: 22, 25, 21, 20, 18, 27, 16, 15, 14, 16, 20, and 22; the average of these widely varying figures being 20 per cent., as above.

The total production of coal was 142,901 tons, of which 67 per cent. went into cars for shipment to market, and 33 per cent. went as wastage.

The wastage varied by months thus: 33, 33, 30, 31, 29, 29, 31, 31, 35, 35, 39, 38; giving an average wastage for the whole period of 33 per cent, as above.

The total wastage of 33 per cent. may be thus sub-divided:

Breaking and Screening, 15.5×80,	12.40
Slate picked at breaker,	4.00
Boiler coal,	3.00
Loading over lip screen, 80×2,	1.60
Going to weigh scales,	1.00
Blasting and refuse,	11.00
	33.00

Colliery No. 8, Elmwood.

This colliery is working the Mammoth coal bed, 12 feet thick, and the seven foot, or 19 feet of coal in all.

The coal dips 30°.

The breaker record is as follows:

1. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2273	
Egg and Stove,	1048	
Chestnut and Pea,	739	
	4060	Per cent. shipped, 70
Dust in tons,	1769	" wasted, 30

2. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3128	
Egg and Stove,	810	
Chestnut and Pea,	545	
	3483	Per cent. shipped, 68
Dust in tons,	1660	" wasted, 32

3. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2225	
Egg and Stove.	1188	
Chestnut and Pea,	739	
	4152	Per cent. shipped, 66
Dust in tons,	2182	" wasted, 34

4. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2883	
Egg and Stove,	1609	
Chestnut and Pea,	972	
	5464	Per cent. shipped, 65
Dust in tons,	2910	" wasted, 35

5. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3224	
Egg and Stove,	1749	
Chestnut and Pea,	1112	
	6085	Per cent. shipped, 65
Dust in tons,	3350	" wasted, 35

6. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3224	
Egg and Stove,	1874	
Chestnut and Pea,	1193	
	6291	Per cent. shipped, 65
Dust in tons,	3428	" wasted, 35

7. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3002	
Egg and Stove,	2144	
Chestnut and Pea,	1355	
	6501	Per cent. shipped, 62
Dust in tons,	4026	" wasted, 38

Mined.	*Shipped.*	*Dust.*	*Rock.*
4,990	4,060	1,769	127
4,565	3,483	1,660	182
5,374	4,152	2,182	203
7,258	5,464	2,910	186
8,090	6,085	3,350	224

Mined.	*Shipped.*	*Dust.*	*Rock.*
7,552	6,291	3,428	120
8,950	6,501	4,026	124
46,779	36,036	19,325	1,166
	19,325		
	1,166		
	56,527		

56,527
46,779

9,748 tons, excess of actual product over computed product from mined car record, or 21 per cent.

The excess varies monthly thus: 19.3, 16.6, 21.6, 17.9, 20, 30.2, 19.0; the average of these being about 21 per cent., as above.

The total coal product was 55,361 tons, of which 65.5 per cent. went to market, and 34.5 per cent. went to wastage.

The waste percentage varied by months thus: 30, 32, 34, 35, 35, 35, 38; the average of these being about 34.5 per cent., as above.

This wastage percentage, 34.5, may be subdivided thus:

Breaking and screening, 78×15.5,	12.10
Slate picked at breaker,	4.00
Boiler coal,	3.00
Loading over lip screen, 78×2,	1.50
Going to weigh scales,	1.00
Blasting and refuse,	12.90
	34.50

Colliery No. 9, Ellangowan.

This colliery works the Mammoth coal bed in three benches, the upper 8 feet, the middle 12 feet and the lower 15 feet thick. These are worked separately.

The coal beds dip 30°.

The breaker records show thus:

1 *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	12,409	
Egg and Stove,	7,500	
Chestnut and Pea,	5,076	
	24,985	Per cent. shipped, 78
Dust in tons,	7,041	" wasted, 22

2. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	5859	
Egg and Stove,	2953	
Chestnut and Pea,	2133	
	10,945	Per cent. shipped, 78
Dust in tons,	3,169	" wasted, 22

3. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	6912	
Egg and Stove,	3364	
Chestnut and Pea,	2624	
	12,900	Per cent. shipped, 77
Dust in tons,	3,903	" wasted, 23

4. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	5054	
Egg and Stove,	3094	
Chestnut and Pea,	2371	
	10,519	Per cent. shipped, 79
Dust in tons,	2,879	" wasted, 21

6. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	7641	
Egg and Stove,	3235	
Chestnut and Pea,	2894	
	13,770	Per cent. shipped, 80
Dust in tons,	3,360	" wasted, 20

7. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	7,182	
Egg and Stove,	3,256	
Chestnut and Pea,	2,851	
	13,289	Per cent. shipped, 80
Dust in tons,	3,426	" wasted, 20

8. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	6469	
Egg and Stove,	2473	
Chestnut and Pea,	1944	
	10,886	Per cent. shipped, 81
Dust in tons,	2,573	" wasted, 19

9. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	6032	
Egg and Stove,	2408	
Chestnut and Pea,	1647	
	10,087	Per cent. shipped, 79
Dust in tons,	2,675	" wasted, 21

Mined.	*Shipped.*	*Dust.*	*Rock.*
31,365	24,985	7,041	1,604
13,772	10,945	3,169	882
15,760	12,900	3,903	1,133
13,042	10,519	2,879	840
17,012	13,770	3,360	980
16,410	13,289	3,426	1,030
13,050	10,886	2,573	760
12,090	10,087	2,675	624
132,501	107,381	29,026	7,853
	7,853		
	29,026		
144,260	144,260		
132,501			
11,761 excess of product over computed coal mined—or 8.8 per cent.			
144,260			
7,853			

136,407 tons of coal as total product, of which 78.8 per cent. went as shipped coal to market, and only 21.2 per cent. went to the dust heap.

The monthly dust waste runs thus, 22, 22, 23, 21, 20, 20, 19, 21 or an average of 21 per cent. wasted, as before.

There are several reasons for the smaller breakage waste at Ellangowan colliery.

1. The coal itself in its physical structure is probably tough instead of the brittle glassy structure sometimes found in the Mammoth bed.

2. The mine is worked on an easy pitch of 30°, thus making but little mine breakage and bringing only a small percentage of dust in the mine car to the breaker.

3. The colliery was running chiefly on large sizes and avoided therefore the heavy loss in breaking down to stove coal and smaller sizes.

4. The colliery is new fashioned and the lump coal and larger sizes do not go down through the breaker crushing themselves and the small coals in their course to the bottom, but the larger sizes are separated at once at the top of the breaker.

5. But even with all these reasons, there is probably some error that makes the wastage too low. The percentage is only enough to cover the breaker waste and leaves nothing for the mine waste.

Colliery No. 10, West Shenandoah.

This colliery works the Seven foot and Mammoth and also the Buck Mountain coal beds, the thickness being—

Seven foot,	7′
Mammoth,	45′
Buck Mountain,	12′

The coal beds are dipping 30.°

The breaker records show—

1. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	5621	
Egg and Stove,	5346	
Chestnut and Pea,	3094	
	14,061	Per cent. shipped, 77
Dust in tons,	4,170	" wasted, 23

2. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3029	
Egg and Stove,	2824	
Chestnut and Pea,	1566	
	7419	Per cent. shipped, 76
Dust in tons,	2329	" wasted, 24

3. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2613	
Egg and Stove,	1858	
Chestnut and Pea,	1253	
	5724	Per cent. shipped, 78
Dust in tons,	1656	" wasted, 22

4. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3045	
Egg and Stove,	2484	
Chestnut and Pea,	1550	
	7079	Per cent. shipped, 79
Dust in tons,	1904	" wasted, 21

5. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2932	
Egg and Stove,	2219	
Chestnut and Pea,	1431	
	6582	Per cent. shipped, 83
Dust in tons,	1388	" wasted, 17

6. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	5648	
Egg and Stove,	2419	
Chestnut and Pea,	1642	
	9709	Per cent. shipped, 78
Dust in tons,	2747	" wasted, 22

7. *Shipped,* *Tons.*

Lump, S. Boat and Broken,	4655	
Egg and Stove,	1874	
Chestnut and Pea,	1290	
	7819	Per cent. shipped, 74
Dust in tons,	2683	" wasted, 26

8. *Shipped.* *Tons.*

Lump, S. Boat and Broken,	5022	
Egg and Stove,	3099	
Chestnut and Pea,	1728	
	9849	Per cent. shipped, 74
Dust in tons,	3431	" wasted, 26

9. *Shipped.* *Tons.*

Lump, S. Boat and Broken,	6480	
Egg and Stove,	4444	
Chestnut and Pea,	2570	
	13,494	Per cent. shipped, 74
Dust in tons,	4,861	" wasted, 26

10. *Shipped.* *Tons.*

Lump, S. Boat and Broken,	6404	
Egg and Stove,	4450	
Chestnut and Pea,	2521	
	13,375	Per cent. shipped, 74
Dust in tons,	4,597	" wasted, 26

11. *Shipped.* *Tons.*

Lump, S. Boat and Broken,	4066	
Egg and Stove,	5017	
Chestnut and Pea,	2640	
	11,723	Per cent. shipped, 71
Dust in tons,	4,734	" wasted, 29

Mined.	*Shipped.*	*Dust.*	*Rock.*
21,170	14,061	4,170	3,113
10,262	7,419	2,329	1,429
7,724	5,724	1,656	1,152
9,271	7,079	1,904	1,491
8,532	6,582	1,388	1,390
11,573	9,709	2,747	1,245
10,885	7,819	2,683	894
13,208	9,849	3,431	720
18,622	13,494	4,861	957
17,590	13,375	4,597	1,150
13,886	11,723	4,734	1,240
142,723	106,834	34,500	14,781
	34,500		
	14,781		
	156,115		

156,115
142,723

13,492 tons excess of actual product over computed mine output.

The total production of coal is 141,334 tons of which 76.5 per cent. were shipped to market and 23.5 per cent. were taken to the waste heap.

The monthly wastage of dust was thus: 23, 24, 22, 21, 17, 22, 26, 26, 26, 26, 29—averaging 23.5 per cent. of wastage, as before.

The West Shenandoah is worked on a moderate dip (30°) and less dirt and refuse would come out in the mine cars; and moreover the colliery sells a large proportion of coal of large sizes.

But even with these facts in its favor, the percentage of actual waste as given above is probably too low. In some collieries the dirt cars are loaded over full, in others under full, depending on their size; and this will change the percentage and make the apparent loss too small.

Colliery No. 11, Boston Run.

This colliery works the Mammoth bed, 25 feet thick. The coal dips 50°.

The breaker records show as follows:

1. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3299	
Egg and Stove,	1836	
Chestnut and Pea,	1652	
	6787	Per cent. shipped, 76
Dust in tons,	2144	" wasted, 24

2. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	5843	
Egg and Stove,	2311	
Chestnut and Pea,	2268	
	10,422	Per cent. shipped, 75
Dust in tons,	3452	" wasted, 25

3. *Shipped.*	*Tons*	
Lump, S. Boat and Broken,	2592	
Egg and Stove,	1112	
Chestnut and Pea,	1069	
	4773	Per cent. shipped, 78
Dust in tons,	1352	" wasted, 22

4. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	1987	
Egg and Stove,	994	
Chestnut and Pea,	1163	
	4147	Per cent. shipped, 73
Dust in tons,	1547	" wasted, 27

5. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2300	
Egg and Stove,	1274	
Chestnut and Pea,	1318	
	4892	Per cent. shipped, 73
Dust in tons,	1842	" wasted, 27

6. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2381	
Egg and Stove,	1193	
Chestnut and Pea.	1226	
	4800	Per cent. shipped, 76
Dust in tons,	1515	" wasted, 24

7. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2921	
Egg and Stove,	1528	
Chestnut and Pea,	1496	
	5945	Per cent. shipped, 75
Dust in tons,	1972	" wasted, 25

8. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2009	
Egg and Stove,	864	
Chestnut and Pea,	955	
	3828	Per cent. shipped, 76
Dust in tons,	1236	" wasted, 24

9. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	1917	
Egg and Stove,	961	
Chestnut and Pea,	1010	
	3888	Per cent. shipped, 76
Dust in tons,	1198	" wasted, 24

10. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2819	
Egg and Stove,	1414	
Chestnut and Pea,	1593	
	5826	Per cent. shipped, 73
Dust in tons,	2204	" wasted, 27

11. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2856	
Egg and Stove,	1458	
Chestnut and Pea,	1561	
	5875	Per cent. shipped, 73
Dust in tons,	2196	" wasted, 27

12. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3532	
Egg and Stove,	1965	
Chestnut and Pea,	2073	
	7570	Per cent. shipped, 75
Dust in tons,	2562	" wasted, 25

Mined.	*Shipped.*	*Dust.*	*Rock.*
8,222	6,787	2,144	662
12,447	10,422	3,452	1,047
5,855	4,773	1,352	426
5,377	4,142	1,547	459
6,812	4,892	1,842	514
6,120	4,800	1,515	532
7,322	5,945	1,972	564
5,102	3,828	1,236	386
4,617	3,888	1,198	311
7,255	5,826	2,204	476
7,020	5,875	2,196	499
9,150	7,570	2,562	581
85,299	68,748	23,220	6,457
	23,220		
	6,457		
	98,425		

98,425
85,299

13,126 tons, excess of actual product over computed product as taken from mine cars, or 15 per cent.

This excess percentage varies by months thus: 17, 20, 12. 14, 6, 12, 16, 7. 17, 17, 22, 17, an average for the 12 months of 15 per cent. excess, as above.

The total product of coal was 91,968 tons, of which 75 per cent. went into the cars for shipment to market, and 25 per cent. went to wastage.

The waste percentage varied by months thus: 24, 25, 22, 27, 27, 24, 25, 24, 24, 27, 27, 25, or an average wastage of 25 per cent. for the whole 12 months, as above.

Colliery No. 12, Conner.

This colliery works the Buck Mountain coal bed, 10 feet to 15 feet thick, and dipping from 4° to 15°. The coal is worked in one bench.

A cubic foot of the dust and coal was carefully weighed and resulted thus:

Dust,	60 pounds.
Chestnut,	55¼ "
Stove,	54 "
Slate,	55 "

The breaker returns show:

1.

Shipped.	*Tons.*	
Lump, S. Boat and Broken,	6210	
Egg and Stove,	4660	
Chestnut and Pea,	2905	
	13,775	Per cent. shipped, 71
Dust in tons,	5529	" wasted, 29

2.

Shipped.	*Tons.*	
Lump, S. Boat and Broken,	5594	
Egg and Stove,	3812	
Chestnut and Pea,	1869	
	11,275	Per cent. shipped, 72
Dust in tons,	4364	" wasted, 28

3.

Shipped.	*Tons.*	
Lump, S. Boat and Broken,	6820	
Egg and Stove,	4784	
Chestnut and Pea,	2549	
	14,153	Per cent. shipped, 69
Dust in tons,	6376	" wasted, 31

4.

Shipped.	*Tons.*	
Lump, S. Boat and Broken,	6717	
Egg and Stove,	4617	
Chestnut and Pea,	2727	
	14,061	Per cent. shipped, 69
Dust in tons,	6444	" wasted, 31

5.

Shipped.	*Tons.*	
Lump, S. Boat and Broken,	6145	
Egg and Stove,	4158	
Chestnut and Pea,	2538	
	12,841	Per cent. shipped, 69
Dust in tons,	5816	" wasted, 31

6.	*Shipped.*	*Tons.*	
	Lump, S. Boat and Broken, Egg and Stove, Chestnut and Pea,	12,290	Per cent. shipped, 67
	Dust in tons,	6186	" wasted, 33

7.	*Shipped.*	*Tons.*	
	Lump, S. Boat and Broken,	6145	
	Egg and Stove,	4158	
	Chestnut and Pea,	2419	
		12,722	Per cent. shipped, 68
	Dust in tons,	5742	" wasted, 32

8.	*Shipped.*	*Tons.*	
	Lump, S. Boat and Broken,	5762	
	Egg and Stove,	4098	
	Chestnut and Pea,	2527	
		12,387	Per cent. shipped, 67
	Dust in tons,	5994	" wasted, 33

9.	*Shipped.*	*Tons.*	
	Lump, S. Boat and Broken,	5600	
	Egg and Stove,	3893	
	Chestnut and Pea,	2365	
		11,858	Per cent. shipped, 68
	Dust in tons,	5579	" wasted, 32

10.	*Shipped.*	*Tons.*	
	Lump, S. Boat and Broken,	4207	
	Egg and Stove,	3585	
	Chestnut and Pea,	2003	
		9795	Per cent. shipped, 67
	Dust in tons,	4864	" wasted, 33

11.	*Shipped.*	*Tons.*	
	Lump, S. Boat and Broken,	3877	
	Egg and Stove,	2824	
	Chestnut and Pea,	1458	
		8159	Per cent. shipped, 67
	Dust in tons,	4027	" wasted, 33

The figures at the Conner colliery for the eleven months are:

Shipped.	*Dust.*
13,775	5,529
11,275	4,364
14,153	6,376
14,061	6,444
12,841	5,816
12,290	6,186

Shipped.	*Dust.*
12,272	5,742
12,387	5,994
11,858	5,579
9,795	4,864
8,159	4,027
132,866	60,921
60,921	

193,787 for a total production, of which there was shipped 68.6 per cent., and wasted 31.4 per cent.

The monthly waste varied thus: 29, 28, 31, 31, 31, 33, 32, 33, 32, 33, 33—giving an average for the eleven months of 31.4 per cent. of waste.

Colliery No. 13, Hammond Colliery.

This works the Mammoth coal bed in two benches, the upper 12 feet thick and the lower 20 feet thick, separated by about 100 feet of interval rock.

The bed dips 35° to 45.° A cubic foot of dust, coal and slate from the shutes was carefully weighed and resulted as follows:

	lbs.
Dust,	57½
Chestnut,	57½
Stove,	56¾
Slate,	58½

The breaker returns show

1. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3915	
Egg and Stove,	2441	
Chestnut and Pea,	1506	
	7862	Per cent. shipped, 49
Dust in tons,	8114	" wasted, 51

2. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2327	
Egg and Stove,	1155	
Chestnut and Pea,	686	
	4158	Per cent. shipped, 49
Dust in tons,	4327	" wasted, 51

3. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3218	
Egg and Stove,	1150	
Chestnut and Pea,	735	
	5103	Per cent. shipped, 51
Dust in tons,	4856	" wasted, 49

4. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	4444	
Egg and Stove,	1668	
Chestnut and Pea,	1010	
	7122	Per cent. shipped, 55
Dust in tons,	5811	" wasted, 45

5. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3580	
Egg and Stove,	1177	
Chestnut and Pea,	902	
	5659	Per cent. shipped, 57
Dust in tons,	4422	" wasted, 43

6. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3418	
Egg and Stove,	1425	
Chestnut and Pea,	1107	
	5950	Per cent. shipped, 61
Dust in tons,	3726	" wasted, 39

7. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	1874	
Egg and Stove,	869	
Chestnut and Pea,	642	
	3385	Per cent. shipped, 60
Dust in tons,	2281	" wasted, 40

8. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3596	
Egg and Stove,	2139	
Chestnut and Pea,	1285	
	7020	Per cent. shipped, 52
Dust in tons,	6356	" wasted, 48

9. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	5335	
Egg and Stove,	2705	
Chestnut and Pea,	1561	
	9601	Per cent. shipped, 55
Dust in tons,	7855	" wasted, 45

10. Shipped.	Tons.	
Lump, S. Boat and Broken,	5119	
Egg and Stove,	2856	
Chestnut and Pea,	1782	
	9757	Per cent. shipped, 53
Dust in tons,	8724	" wasted, 47

Mined.	*Shipped.*	*Dust.*
14,655	7,862	8,114
8,126	4,158	4,327
9,259	5,103	4,856
11,689	7,122	5,811
9,688	5,659	4,422
9,873	5,950	3,726
5,945	3,385	2,281
11,197	7,020	6,356
15,609	9,601	7,855
18,276	9,757	8,724
114,317	65,617	56,472
	56,472	
	122,089	

122,089
114,317

7,772 tons, excess of actual product over the computed mined coal, or 6.3 per cent.

Total coal mined 122,089 tons, of which 53.9 per cent. were shipped and 46.1 per cent. were wasted.

The percentage of waste by months shows great variation thus: 51, 51, 49, 45, 43, 39, 40, 48, 45, 47. An average of 46 per cent. as before.

The enormous waste of this colliery is due to—

1. The extreme brittleness of the coal itself.

2. That but little chestnut and pea coal is shipped, most of these small sizes going on to the dust pile.

3. The old-fashioned breaker, by which the coal travels all through the screens, and the large sizes come out at the bottom of the breaker.

Colliery No. 14, Preston No. 3.

This colliery works the Mammoth coal bed, 18′ to 20 feet thick, worked as one bench. The coal dips steeply, 75° to 80°.

A cubic foot of coal dust, coal, and slate, was carefully weighed at the colliery, and gave—

Dust,	59¼ lbs.
Chestnut,	54 "
Stove,	52¼ "
Slate,	63½ "

These weights are not entirely satisfactory, the dust being somewhat too heavy.

The breaker results are—

1. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3267	
Egg and Stove,	2954	
Chestnut and Pea,	2397	
	8618	Per cent. shipped, 48
Dust in tons,	9429	" wasted, 52

2. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2122	
Egg and Stove,	1566	
Chestnut and Pea,	1355	
	5043	Per cent. shipped, 50
Dust in tons,	5066	" wasted, 50

Mined.	*Shipped.*	*Dust.*
15,159	8,618	9,429
8,853	5,043	5,066
24,012	13,661	14,495
	14,495	
	28,156	

28,156
24,012

4,144 tons, excess of product over computed coal mined, or 17.2 per cent.

Of the total product, 28,156 tons, 49 per cent. were shipped to market, and 51 per cent. was wasted.

The wastage computations at the Preston No. 3 were not carried forward on account of inaccuracy in size of dirt car.

The Girard colliery, adjoining and on the same bed, will furnish more accurate figures, and in all disagreements between the records of the two collieries the doubtful point should be decided in favor of the Girard.

Colliery No. 15, Girard.

This colliery works the Mammoth coal bed 40 feet thick, and on a dip of 60.°

The breaker record shows as follows:

1. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3952	
Egg and Stove,	2781	
Chestnut and Pea,	756	
	7489	Per cent. shipped 41
Dust in tons,	10,680	" wasted, 59

2. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	6053	
Egg and Stove,	3078	
Chestnut and Pea,	950	
	10,081	Per cent. shipped, 41
Dust in tons,	14,547	" wasted, 59

3. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3278	
Egg and Stove,	1895	
Chestnut and Pea,	491	
	5664	Per cent. shipped, 45
Dust in tons,	6917	" wasted, 55

4. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3558	
Egg and Stove,	1674	
Chestnut and Pea,	540	
	5772	Per cent. shipped, 41
Dust in tons,	8186	" wasted, 59

5. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3488	
Egg and Stove,	1528	
Chestnut and Pea,	492	
	5508	Per cent. shipped, 42
Dust in tons,	7569	" wasted, 58

6. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	4844	
Egg and Stove,	1949	
Chestnut and Pea,	572	
	7365	Per cent. shipped, 47
Dust in tons,	8186	" wasted, 53

7. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken, . .	. 4320	
Egg and Stove, ...	. 1690	
Chestnut and Pea, ...	534	
	6544	Per cent. shipped, 47
Dust in tons, ...	. 7246	" wasted, 53

8. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken, . .	. 4255	
Egg and Stove, ...	. 1528	
Chestnut and Pea, ...	. 475	
	6258	Per cent. shipped, 46
Dust in tons, ...	. 7226	" wasted, 54

Mined.	*Shipped.*	*Dust.*	*Rock.*
17,987	7,489	10,680	2,083
23,427	10,081	14,547	2,690
10,835	5,664	6,917	901
13,050	5,772	8,186	1,173
11,960	5,508	7,569	1,014
15,307	. 7,364	8,186	1,076
12,780	6,544	7,246	1,093
12,571	6,258	7,226	1,121
117,917	54,680	70,557	. 11,151
	70,557		
	11,151		
	136,388		

136,388
117,917

18,471 tons, excess of actual product over the calculated mined product from mine cars, or 15.6 per tent.

This excess percentage runs by months thus: 12.6, 16.6, 24.4, 15.9, 17, 7.9, 16.4, 16.2, averaging about 15.6 per cent., as above.

The total coal mined is 126,237 tons, of which 43.6 per cent. went into cars for shipment to market and 56.4 per cent. went to wastage.

The wastage percentage by months, varies thus: 59, 59, 55, 59, 58, 53, 53, 54, averaging about 56.4 per cent., as above.

This wastage percentage is very high. The bed is large, is pitching 60,° and the amount of refuse made in the mine is very great.

Moreover the Girard colliery only ships 10 per cent. of

Chestnut and Pea coal, while Preston No. 3 adjoining, on same bed and same pitch, has 25 per cent of small sizes, Chestnut and Pea. Much of the small coal therefore at the Girard must go on to the dust pile and thus help to swell the total percentage of waste.

2. Free-burning White Ash Coals.

Colliery No. 16, Tunnel.

This colliery works the Mammoth coal bed, 20 to 30 feet thick, with some 16 to 18 feet of good coal in it.

The coal dips 60° to 70°.

The breaker record shows as follows:

1. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2317	
Egg and Stove,	1895	
Chestnut and Pea,	2678	
	6890	Per cent. shipped, 53
Dust in tons,	6030	" wasted, 47

2. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	4477	
Egg and Stove,	3634	
Chestnut and Pea,	4282	
	12,393	Per cent. shipped, 60
Dust in tons,	8337	" wasted, 40

3. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3505	
Egg and Stove,	2889	
Chestnut and Pea,	4314	
	10,708	Per cent. shipped, 61
Dust in tons,	6867	" wasted, 39

4. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	4542	
Egg and Stove,	3796	
Chestnut and Pea,	5351	
	13,689	Per cent. shipped, 58
Dust in tons,	10,091	" wasted, 42

5. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3780	
Egg and Stove,	2711	
Chestnut and Pea,	4098	
	10,589	Per cent. shipped, 57
Dust in tons,	8148	" wasted, 43

6. *Shipped.*	*Tons.*
Lump, S. Boat and Broken,	2441
Egg and Stove,	1814
Chestnut and Pea,	2203
	6458 (Per cent. shipped, 55
Dust in tons,	5321 (" wasted, 45

Mined.	*Shipped.*	*Dust.*	*Rock.*
17,346	6,890	6,030	1,513
23,648	12,393	8,337	1,126
19,836	10,708	6,867	1,020
27,534	13,689	10,091	1,788
22,815	10,589	8,148	1,698
13,595	6,458	5,321	932
124,774	60,727	44,794	8,127
	44,794		
	8,127		
	113,648		
124,774			
113,648			

11,126 tons, excess of mined coal, as calculated from mine car record, over actual product, or 8.9 per cent.

This excess percentage varies monthly, thus: 6.1, 10, 7.1, 6.2, 7.6, 16.7; the average excess being 8.9 per cent., as above.

The total coal product amounted to 105,521 tons, of which 57.6 per cent. went to market, and 42.4 per cent. went to wastage.

The waste percentage varied thus by months: 45, 43, 42, 39, 40, 47; the average being about 42.4 per cent., as above.

In subdividing the wastage of free-burning white ash coals into the component parts which go to make up the total percentage, the wastage for boiler coal, loading from lip screens, going to weigh scales, &c., may be taken as at the same rate as with hard white ash collieries; but the breaker waste in breaking and screening should be put at about 20 per cent. instead of 15.5 per cent.

Colliery No. 17, Potts.

This colliery works the Mammoth coal bed, between 20 and 30 feet thick, with some 16 to 18 feet of good coal.

The coal dips 55°.

The breaker records are as follows:

1. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2824	
Egg and Stove,	4379	
Chestnut and Pea,	3807	
	11,010	Per cent. shipped, 55
Dust in tons,	9017	" wasted, 45

2. *Shipped.*	*Tons.*	
Lump S. Boat and Broken,	1831	
Egg and Stove,	1971	
Chestnut and Pea,	1868	
	5670	Per cent. shipped, 51
Dust in tons,	5554	" wasted, 49

3. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	1631	
Egg and Stove,	1793	
Chestnut and Pea,	1684	
	5108	Per cent. shipped, 52
Dust in tons,	4716	" wasted, 48

4. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2117	
Egg and Stove,	2311	
Chestnut and Pea,	1992	
	6420	Per cent. shipped, 54
Dust in tons,	5379	" wasted, 46

5. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2727	
Egg and Stove,	2624	
Chestnut and Pea,	2214	
	7565	Per cent. shipped, 53
Dust in tons,	6604	" wasted, 47

6. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	1334	
Egg and Stove,	1188	
Chestnut and Pea,	1009	
	3531	Per cent. shipped, 49
Dust in tons,	3692	" wasted, 51

Mined.	*Shipped.*	*Dust.*	*Rock.*
14,664	11,010	9,017	1,276
9,090	5,670	5,554	873
7,962	5,108	4,716	736
9,465	6,420	5,379	797

Mined.	*Shipped.*	*Dust.*	*Rock.*
11,250	7,565	6,604	859
5,619	3,531	3,692	422
58,050	39,304	34,962	4,963
	34,962		
	4,963		
	79,229		
79,229			
58,050			

21,179 tons, excess of actual product over the calculated mine yield taken from mine car record, or 36.4 per cent.

This excess percentage varies monthly, thus: 45.3, 33.1, 32.6, 33.1, 24.7, 36.; the average being about 34 per cent.

The total coal produced amounted to 74,266 tons, of which 52.3 per cent. was shipped to market, and 47.7 per cent. went to wastage.

This wastage varied monthly, thus: 45, 49, 48, 46, 47, 51; the average being a wastage of 47.7 per cent., as before.

Colliery No. 18, Keystone.

This colliery works the Mammoth coal bed, some 20 feet thick, and on a dip of 60.°

The breaker records show thus:

1. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2959	
Egg and Stove,	2068	
Chestnut and Pea,	2057	
	7084	Per cent. shipped, 47
Dust in tons,	7850	" wasted, 53

2. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2398	
Egg and Stove,	1571	
Chestnut and Pea,	1771	
	5740	Per cent. shipped, 49
Dust in tons,	6087	" wasted, 51

3. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	1901	
Egg and Stove,	1328	
Chestnut and Pea,	1328	
	4557	Per cent. shipped, 47
Dust in tons,	5189	" wasted, 53

4. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2160	
Egg and Stove,	1490	
Chestnut and Pea,	1220	
	4870	Per cent. shipped, 49
Dust in tons,	5085	" wasted, 51

5. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	4045	
Egg and Stove,	2322	
Chestnut and Pea,	2597	
	8964	Per cent. shipped, 52
Dust in tons,	8358	" wasted, 48

Mined.	*Shipped.*	*Dust.*	*Rock.*
15,049	7,084	7,850	1,348
12,002	5,740	6,087	1,165
10,523	4,557	5,189	1,202
10,421	4,870	5,085	1,045
16,941	8,964	8,358	1,532
64,936	31,215	32,569	6,292
	32,569		
	6,292		
	70,076		

70,076
64,936

5,140 tons, excess of product over computed mine yield, or 7.9 per cent.

The total coal mined is 63,784 tons, of which 49 per cent. went into cars for shipment to market and 51 per cent. went on to the waste heap.

The monthly variation of dust wastage is thus: 53, 51, 53, 51, 48, giving an average of 51 per cent., as above.

This enormous wastage is due to several causes.

1. The coal is pitching 60° and much waste is made in the mine, and must all come out in the mine car.

2. The actual breaker waste is about 5 per cent. greater than at the hard white ash collieries.

3. Probably some deduction must be made for heavy loading of dust dumpers.

Colliery No. 19, Locust Spring.

This colliery works the Mammoth coal bed, in one bench, 25 feet thick.

The coal bed dips 25.°

The breaker record shows thus :

1. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2786	
Egg and Stove,	5103	
Chestnut and Pea,	3321	
	11,210	Per cent. shipped, 63
Dust in tons,	6677	" wasted, 37

2. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	1955	
Egg and Stove,	2835	
Chestnut and Pea,	2008	
	6798	Per cent. shipped, 64
Dust in tons,	3809	" wasted, 36

3. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2057	
Egg and Stove,	2446	
Chestnut and Pea,	1577	
	6080	Per cent. shipped, 62
Dust in tons,	3707	" wasted, 38

4. *Shipped.*	*Tons.*	
Lump, S Boat and Broken,	2290	
Egg and Stove,	2802	
Chestnut and Pea,	2032	
	7122	Per cent. shipped, 64
Dust in tons,	4035	" wasted, 36

5. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2424	
Egg and Stove,	2608	
Chestnut and Pea,	1701	
	6733	Per cent. shipped, 64
Dust in tons,	3745	" wasted, 36

6. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	4045	
Egg and Stove,	2662	
Chestnut and Pea,	2100	
	8807	Per cent. shipped, 66
Dust in tons,	4525	" wasted, 34

7. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3056	
Egg and Stove,	2662	
Chestnut and Pea,	1420	
	7138	Per cent. shipped, 66
Dust in tons,	3608	" wasted, 34

Mined.	*Shipped.*	*Dust.*	*Rock.*
15,031	11,210	6,667	426
8,977	6,798	3,809	258
8,156	6,080	3,707	292
9,000	7,122	4,035	274
8,643	6,733	3,745	252
11,010	8,807	4,525	295
9,194	7,138	3,608	285
70,011	53,888	30,106	2,082
	30,106		
	2,082		
	86,076		
86,076			
70,011			
16,065 tons, excess of product over computed mine yield.			

The total yield is 83,994 tons, of which 64.2 per cent. went to market, and 35.8 per cent. went on to the dust heap.

The monthly percentages of waste run thus: 37, 36, 38, 36, 36, 34, 34; giving an average of 35.8 per cent., as above.

Colliery No. 20, Mount Carmel Shaft.

This colliery works the Mammoth bed. The bed measures thus:

Upper bench,	9′	all worked together.
Slate,	4′	
Lower bench,	5′	

The bed dips from 30° down to 12° or less.

A cubic foot of the dust was weighed at this colliery, direct from the shutes, without packing, and gave 53½ lbs.

Chestnut coal weighed (per cubic foot),	55¾ lbs.
Slate weighed (per cubic foot),	60¾ lbs.

The total yield of shipped coal and dust exceeds the computed yield from mine car measurement sufficiently to commend the accuracy of the figures taken from computation of mine and breaker waste.

The breaker waste by months shows:

1. *Shipped.*	*Tons.*	
Broken, Egg and Stove,	11,345	
Chestnut and Pea,	2,295	
	13,640	Per cent. shipped, 65
Dust in tons,	7,235	" wasted, 35

2.	*Shipped.*	*Tons.*	
	Broken, Egg and Stove,	10,557	
	Chestnut and Pea,	2,592	
		13,149	Per cent. shipped, 64
	Dust in tons,	7,420	" wasted, 36

3.	*Shipped.*	*Tons.*	
	Broken, Egg and Stove,	12,009	
	Chestnut and Pea,	3,294	
		15,303	Per cent. shipped, 64
	Dust in tons,	8,453	" wasted, 36

4.	*Shipped.*	*Tons.*	
	Broken, Egg and Stove,	14,364	
	Chestnut and Pea,	3,812	
		18,176	Per cent. shipped, 66
	Dust in tons,	9,386	" wasted, 34

5.	*Shipped.*	*Tons.*	
	Broken, Egg and Stove,	13,829	
	Chestnut and Pea,	3,704	
		17,533	Per cent. shipped, 64
	Dust in tons,	9,811	" wasted, 36

6.	*Shipped.*	*Tons.*	
	Broken, Egg and Stove,	11,410	
	Chestnut and Pea,	3,353	
		14,763	Per cent. shipped, 61
	Dust in tons,	9,409	" wasted, 39

7.	*Shipped.*	*Tons.*	
	Broken, Egg and Stove,	12,971	
	Chestnut and Pea,	3,580	
		16,551	Per cent. shipped, 62
	Dust in tons,	10,006	" wasted, 38

8.	*Shipped.*	*Tons.*	
	Broken, Egg and Stove,	12,976	
	Chestnut and Pea,	3,434	
		16,410	Per cent. shipped, 62
	Dust in tons,	9,847	" wasted, 38

9.	*Shipped.*	*Tons.*	
	Broken, Egg and Stove,	13,602	
	Chestnut and Pea,	3,699	
		17,301	Per cent. shipped, 63
	Dust in tons,	10,000	" wasted, 37

10. *Shipped.*	*Tons.*	
Broken, Egg and Stove,	14,887	
Chestnut and Pea,	3,888	
	18,775	Per cent. shipped, 64
Dust in tons,	10,512	" wasted, 36

11. *Shipped.*	*Tons.*	
Broken, Egg and Stove,	12,312	
Chestnut and Pea,	3,083	
	15,395	Per cent. shipped, 66
Dust in tons,	7,761	" wasted, 34

12. *Shipped.*	*Tons.*	
Broken, Egg and Stove,	9,628	
Chestnut and Pea,	2,684	
	12,312	Per cent. shipped, 66
Dust in tons,	6,403	" wasted, 34

Mined.	*Shipped.*	*Dust.*
20,035	13,640	7,235
19,500	13,149	7,420
21,730	15,303	8,453
26,118	18,176	9,386
26,684	17,533	9,811
24,623	14,763	9,409
25,915	16,551	10,006
26,154	16,410	9,847
24,457	17,301	10,000
27,750	18,775	10,512
23,246	15,395	7,761
17,753	12,312	6,403
283,975	190,208	106,243
	106,243	
296,451	296,451	
283,975		
12,476		

The total of dust and shipped coal exceeds the calculated mined coal by 12,476 tons or 4 per cent. This is probably closely correct.

The monthly excess of product over the calculated mined coal runs 4.2, 5.4, 9.3, 5.5, 2.5, 2.5, 0.4, 7.2, 5.5, 0.4, 5.4, and one month—2.2, giving an average excess of 3.8 as computed by months.

The total product is 296,451 tons, of which amount there was

Shipped, ... 64.1 per cent.
Wasted, ... 35.9 "

The average waste by months runs thus: 35, 36, 36, 34, 36, 39, 38, 38, 37, 36, 34, 34, an average of 36 per cent.

3. Shamokin Coals.

Colliery No. 21, Burnside.

This colliery works the Mammoth coal bed. It is in two benches, each 10 feet thick, or 20 feet in all, and is worked as one bed.

The dip is from 20° up to 50°.

A cubic foot of the coal dust from the shutes was weighed at Burnside and gave 52 lbs. for the weight of the dust.

The breaker record shows thus:

1. *Shipped.*	*Tons.*	
Egg and Stove,	3520	
Chestnut and Pea,	2981	
	6501	Per cent. shipped, 59
Dust in tons,	4578	" wasted, 41

2. *Shipped.*	*Tons.*	
Egg and Stove,	17,004	
Chestnut and Pea,	9,666	
	26,670	Per cent. shipped, 60
Dust in tons,	17,445	" wasted, 40

3. *Shipped.*	*Tons.*	
Egg and Stove,	3180	
Chestnut and Pea,	1739	
	4919	Per cent. shipped, 62
Dust in tons,	3062	" wasted, 38

4. *Shipped.*	*Tons.*	
Egg and Stove,	5449	
Chestnut and Pea,	3083	
	8532	Per cent. shipped, 62
Dust in tons,	5280	" wasted, 38

5. *Shipped.*	*Tons.*	
Egg and Stove,	5600	
Chestnut and Pea,	3202	
	8802	Per cent. shipped, 60
Dust in tons,	5889	" wasted, 40

6. *Shipped.*	*Tons.*	
Egg and Stove,	4390	
Chestnut and Pea,	2624	
	7014	Per cent. shipped, 61
Dust in tons,	4470	" wasted, 39

7. *Shipped.*	*Tons.*	
Egg and Stove,	4066	
Chestnut and Pea,	2316	
	6382	Per cent. shipped, 62
Dust in tons,	4075	" wasted, 38

8. *Shipped.*	*Tons.*	
Egg and Stove,	4233	
Chestnut and Pea,	2376	
	6609	Per cent shipped, 62
Dust in tons,	4028	" wasted, 38

Mined.	*Shipped.*	*Dust.*
12,323	6,501	4,578
(6 mos.) 48,999	26,670	17,445
7,711	4,919	3,062
14,171	8,532	5,280
15,516	8,802	5,889
12,229	7,014	4,470
11,698	6,382	4,075
11,678	6,609	4,028
134,325	75,429	48,827
	48,827	
	124,256	

134,325
124,256

10,069 tons, excess of mined coal over computed coal mined, or 7.4 per cent.

The total product is 124,256 tons, of which 61 per cent. was shipped to market and 39 per cent. carried on to the dust heap.

The monthly dust percentages ran thus: 41, 40, 38, 38, 40, 39, 38, 38, an average of 39 per cent wasted, as before.

In calculating the proper subdivisions of the total wastage percentage of the Shamokin coals the percentage of waste due to breaking and screening the coal is about the same as that in the case of the free burning white ash.

The coal, being softer than the hard white ash coals, crushes somewhat more, but it is tough and does not go

down to buckwheat coal, though it makes a large percentage of chestnut and pea sizes.

As the demand for this coal is for sizes ranging from egg down to pea, the extra waste in breaking down all the coal from the mine probably brings the total waste for *breaking and screening* up to 21 to 22 per cent. of the coal put into the breaker.

Colliery No. 22, North Franklin, No. 2.

This colliery works the Mammoth bed. Coals No. 8 and 9 are here 100 feet apart. No. 8 yields 7 to 12 feet of coal, and No. 9 yields from 8 to 13 feet.

The beds dip at an angle of 45.°

The dust from this colliery contains great quantities of "buckwheat coal;" there is no sale for this small size and the coal is thrown away with the dust.

A cubic foot of this dust was carefully weighed, without packing, just as it fell from the breaker, and gave 48¼ pounds.

The weights were per cubic foot.

Dust,	48¼	lbs.
Chestnut coal,	49¼	
Stove coal,	49¼	

The total yield of shipped coal and dust being less than the computed yield from mined car measurement, instead of more as it naturally should be, leads me to believe that a cubic foot of dust in the car must be somewhat packed and therefore weighs more than 48¼ pounds. But as the weighing was carefully done the computations have been made on the figures gained at the colliery.

The breaker waste by months shows

1. *Shipped.*	*Tons.*	
Egg and Stove,	5,994	
Chestnut and Pea,	6,080	
	12,074	Per cent. shipped, 51
Dust in tons,	11,503	" wasted, 49

2. *Shipped.*	*Tons.*	
Egg and Stove,	3067	
Chestnut and Pea,	2856	
	5923	Per cent. shipped, 51
Dust in tons,	5648	" wasted, 49

3. *Shipped.*	*Tons.*	
Egg and Stove,	2370	
Chestnut and Pea,	2263	
	4633	Per cent. shipped, 49
Dust in tons,	4878	" wasted, 51

4. *Shipped.*	*Tons.*	
Egg and Stove,	17,242	
(6 mos.) Chestnut and Pea,	14,321	
	31,563	Per cent. shipped, 51
Dust in tons,	30,000	" wasted, 49

5. *Shipped.*	*Tons.*	
Egg and Stove,	5,848	
Chestnut and Pea,	4,946	
	10,794	Per cent. shipped, 54
Dust in tons,	9,067	" wasted, 46

6. *Shipped.*	*Tons.*	
Egg and Stove,	6,475	
Chestnut and Pea,	5,772	
	12,247	Per cent. shipped, 56
Dust in tons,	9,601	" wasted, 44

Mined.	*Totals. Shipped.*	*Dust.*
20,840	12,074	11,503
11,723	5,923	5,648
9,290	4,633	4,878
79,515	31,563	30,000
18,922	10,794	9,067
19,854	12,247	9,601
160,144	77,234	70,697
147,931	70,697	
12,213	147,931	

Excess of mined coal computed from cubic feet of mine cars over actual output of shipped coal and dust (12,213 tons) 7.6 per cent.

Average of total coal shipped and dust, 47.7 per cent.

Average of coal and dust by months, 49, 49, 51, 49, 46, 44=48.0 per cent.

Therefore, of the coal mined 52 per cent. went to market, and 48 per cent. to the dust pile.

This coal shatters into small pieces, and the coal dust as hauled to the dirt dumps contains fully one half of buckwheat coal. As this is all waste it adds much to the wastage, and makes the percentage of wastage for *breaking and screening* run up to between 25 and 30 per cent.

Moreover, this coal is sold in sizes ranging from egg down to pea coal.

Chapter VI.

Waste in breaking anthracite coal continued.—First basin from Pottsville to Lykens Valley.

1. Free-burning White Ash Coals.

Colliery No. 23, Pine Forest.

This colliery works the Seven Foot coal, and also the top and bottom benches of the Mammoth coal bed, 6 feet and 15 feet thick, respectively, in all 28 feet of coal; it has also opened a coal below, 7 feet thick.

The coal beds dip 35°.

The breaker record shows as follows:

1. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	1118	
Egg and Stove,	1938	
Chestnut and Pea,	1555	
	4611	Per cent. shipped, 51
Dust in tons,	4445	" wasted, 49

2. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	788	
Egg and Stove,	1766	
Chestnut and Pea,	1145	
	3699	Per cent. shipped, 49
Dust in tons,	3802	" wasted, 51

3. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	783	
Egg and Stove,	1490	
Chestnut and Pea,	1026	
	3299	Per cent. shipped, 54
Dust in tons,	2857	" wasted, 46

4. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	848	
Egg and Stove,	2057	
Chestnut and Pea,	1307	
	4212	Per cent. shipped, 53
Dust in tons,	3683	" wasted, 47

5. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	1377	
Egg and Stove,	1739	
Chestnut and Pea,	1069	
	4185	Per cent. shipped, 56
Dust in tons,	3297	" wasted, 44

6. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	1615	
Egg and Stove,	2208	
Chestnut and Pea,	1155	
	4978	Per cent. shipped, 57
Dust in tons,	3767	" wasted, 43

7. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	1642	
Egg and Stove,	1658	
Chestnut and Pea,	1036	
	4336	Per cent. shipped, 54
Dust in tons,	3500	" wasted, 46

Mined.	*Shipped.*	*Dust.*	*Rock.*
8,676	4,611	4,445	598
7,107	3,699	3,802	421
5,583	3,299	2,857	264
7,376	4,212	3,683	312
6,981	4,185	3,297	304
7,951	4,978	3,767	400
7,012	4,336	3,500	391
50,686	29,320	25,351	2,690
	25,351		
	2,690		
	57.361		
57,361			
50,686			

6,675 tons, excess of actual product over computed mine product taken from mine car record, or 13.2 per cent.

This excess percentage varies monthly, thus: 11.3, 11.6, 15.2, 11.2, 11.5, 15, 17.3, or an average of 13.2, as above.

The total coal mined amounts to 54,681 tons, of which 53.6 per cent. went into the cars for shipment to market, and 46.4 per cent. went to wastage.

This waste percentage varied monthly thus: 46, 43, 44, 47, 46, 51, and 49, averaging as above—about 46.4 per cent.

In subdividing the total wastage percentage of these free

burning white ash collieries into the various factors which go to make up the total, the actual waste in breaking and screening is apparently about the same as the waste of the free burning coals in the Second basin.

An average of 20 to 21 per cent. for breaker waste will apply to all these collieries, the waste being the same at all of them, provided they are running on the same sizes.

Of course the actual percentage of dust will vary with the mine waste, which on steep pitches will increase the amount of dust to be hauled away from the breaker.

Colliery No. 24, Wadesville Shaft.

This colliery works the Mammoth coal bed with an upper bench of 8 feet and a lower bench of 25 feet thick, or 33 feet in all.

The dip of the coal bed is 15.°

The breaker records show as follows:

1. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	1571	
Egg and Stove,	5643	
Chestnut and Pea,	2916	
	10,130	Per cent. shipped, 60
Dust in tons,	6779	" wasted, 40

2. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	1836	
Egg and Stove,	6550	
Chestnut and Pea,	4017	
	12,403	Per cent. shipped, 62
Dust in tons,	7740	" wasted, 38

3. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	756	
Egg and Stove,	3683	
Chestnut and Pea,	2273	
	6712	Per cent. shipped, 61
Dust in tons,	4335	" wasted, 39

4. *Shipped.*	*Tons.*	
Broken,	632	
Egg and Stove,	3235	
Chestnut and Pea,	1857	
	5724	Per cent. shipped, 62
Dust in tons,	3557	" wasted, 38

5. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	821	
Egg and Stove,	3710	
Chestnut and Pea,	2192	
	6723	Per cent. shipped, 62
Dust in tons,	4168	" wasted, 38

6. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2398	
Egg and Stove,	2246	
Chestnut and Pea,	1506	
	6150	Per cent. shipped, 66
Dust in tons,	3215	" wasted, 34

7. *Shipped,*	*Tons.*	
Lump, S. Boat and Broken,	2900	
Egg and Stove,	3267	
Chestnut and Pea,	2208	
	8375	Per cent. shipped, 64
Dust in tons,	4654	" wasted, 36

8. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2878	
Egg and Stove,	2705	
Chestnut and Pea,	2009	
	7592	Per cent. shipped, 64
Dust in tons,	4177	" wasted, 36

9. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3515	
Egg and Stove,	3812	
Chestnut and Pea,	2722	
	10,049	Per cent. shipped, 74
Dust in tons,	3541	" wasted, 26

10. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3844	
Egg and Stove,	4914	
Chestnut and Pea,	2916	
	11,674	Per cent. shipped, 67
Dust in tons,	5742	" wasted, 33

Mined.	*Shipped.*	*Dust.*	*Rock.*
18,392	10,130	6,779	101
20,288	12,403	7,740	120
11,756	6,712	4,335	70
9,781	5,724	3,557	56
11,265	6,723	4,168	63
9,072	6,150	3,215	46
12,889	8,375	4,654	61

Mined.	*Shipped.*	*Dust.*	*Rock.*
11,525	7,592	4,177	60
14,415	10,049	3,541	53
18,373	11,674	5,742	75
137,756	85,532	47,908	705
	47,908		
	705		
	134,145		

137,756
134,145

3,611 tons, which is the amount less than the computed mined coal—or $2\frac{3}{4}$ per cent.

The total coal yield is 133,455 tons, of which 64 per cent. went into cars for shipment to market, and 36 per cent. went to the dirt heap.

The percentage of waste by months runs thus: 38, 40, 39, 38, 38, 34, 36, 36, 26, 33, or an average of 36 per cent., as above.

Colliery No. 25, Beechwood.

This colliery works the Mammoth coal bed, top and bottom benches, in all 45 feet thick. The coal is nearly horizontal, dipping not over 10°.

The breaker records are as follows:

1. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	216	
Egg and Stove,	1890	
Chestnut and Pea,	1474	
	3580	Per cent. shipped, 69
Dust in tons,	1606	" wasted, 31

2. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	561	
Egg and Stove,	1436	
Chestnut and Pea,	1307	
	3304	Per cent. shipped, 69
Dust in tons,	1491	" wasted, 31

3. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	1123	
Egg and Stove,	1021	
Chestnut and Pea,	1047	
	3191	Per cent. shipped, 69
Dust in tons,	1420	" wasted, 31

4. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	1615	
Egg and Stove,	1787	
Chestnut and Pea,	1647	
	5049	Per cent. shipped, 72
Dust in tons,	1995	" wasted, 28

5. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	1771	
Egg and Stove,	1965	
Chestnut and Pea,	1566	
	5302	Per cent. shipped, 76
Dust in tons,	1641	" wasted, 24

6. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2063	
Egg and Stove,	2452	
Chestnut and Pea,	1938	
	6453	Per cent. shipped, 74
Dust in tons,	2308	" wasted, 26

Mined.	*Shipped.*	*Dust.*	*Rock.*
6,609	3,580	1,606	627
5,774	3,304	1,491	517
5,435	3,191	1,420	524
8,622	5,049	1,995	752
6,918	5,302	1,641	686
10,315	6,453	2,308	1,054
43,673	26,879	10,461	4,160
	10,461		
	4,160		
	41,500		
43,673			
41,500			

2,173 tons, excess of calculated mined coal from mine car record, over actual product, or 5 per cent.

This excess of calculated mined coal over product varies thus by months:—4.6,—9.5,+10,—5.5,—8,—12; giving an average of 5 per cent., as above.

The total coal produced amounted to 37,340 tons, of which 72 per cent. went into cars to go to market, and 28 per cent. went to wastage.

This waste percentage varied monthly, thus: 31, 31, 31, 28, 24, 26, averaging 28 per cent., as above.

Colliery No. 26, Mine Hill Gap.

This colliery works the Mammoth coal bed, the upper bench being 12 feet and the lower bench 15 feet thick, or 27 feet in all.

The coal dips 50.

The breaker record shows as follows:

1. *Shipped.*	*Tons.*	
Lump, S. Boat, and Broken,	567	
Egg and Stove,	3542	
Chestnut and Pea,	2435	
	6544	Per cent. shipped, 46
Dust in tons,	7546	" wasted, 54

2. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	513	
Egg and Stove,	1533	
Chestnut and Pea,	848	
	2894	Per cent. shipped, 50
Dust in tons,	2919	" wasted, 50

3. *Shipped.*	*Tons.*	
Lump, S. Boat, and Broken,	1420	
Egg and Stove,	1420	
Chestnut and Pea,	697	
	3537	Per cent. shipped, 42
Dust in tons,	4805	" wasted, 58

4. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	1928	
Egg and Stove,	2117	
Chestnut and Pea,	604	
	4649	Per cent. shipped, 42
Dust in tons,	6471	" wasted, 58

5. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	1728	
Egg and Stove,	1658	
Chestnut and Pea,	1371	
	4757	Per cent. shipped, 49
Dust in tons,	4902	" wasted, 51

6. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2317	
Egg and Stove,	2630	
Chestnut and Pea,	2532	
	7479	Per cent. shipped, 47
Dust in tons,	8539	" wasted, 53

Mined.	*Shipped.*	*Dust,*	*Rock.*
16,121	6,544	7,546	1,179
6,621	2,894	2,919	547
10,170	3,537	4,805	893
13,938	4,649	6,471	1,400
10,431	4,757	4,902	796
18,266	7,479	8,539	1,363
75,547	29,860	35,182	6,178

35,182
6,178

71,220

75,547
71,220

4,327 tons, excess of calculated mined tonnage over actual product, or 5.7 per cent.

This excess percentage varies by months, thus: 5.2, 3.9, 9, 10.1, 4.8, giving an average of about 5.7 per cent., as above.

The total coal product amounted to 65,042 tons, of which 46 per cent. went to market and 54 per cent. went to wastage.

The waste percentage varied thus by months: 54, 50, 58, 58, 51, 53; giving an average waste percentage of 54, as above.

Colliery No. 27, Pottsville Mine.

This colliery works the Diamond and Primrose coal beds, the Diamond 5 and the Primrose 3 feet thick, or 8 feet in all. They are worked separately, and the coal beds dip 40°.

The breaker records show as follows:

1. *Shipped.*	*Tons.*	
Egg and Stove,	1474	
Chestnut and Pea,	1139	
	2613	Per cent. shipped, 51
Dust in tons,	2547	" wasted, 49

2. *Shipped.*	*Tons.*	
Egg and Stove,	2851	
Chestnut and Pea,	2862	
	5713	Per cent. shipped, 53
Dust in tons,	4977	" wasted, 47

3. *Shipped.*	*Tons.*	
Egg and Stove,	2376	
Chestnut and Pea,	2208	
	4584	Per cent. shipped, 58
Dust in tons,	3278	" wasted, 42

4. *Shipped.*	*Tons.*	
Egg and Stove,	2160	
Chestnut and Pea,	1944	
	4104	Per cent. shipped, 58
Dust in tons,	2938	" wasted, 42

5. *Shipped.*	*Tons.*	
Egg and Stove,	2646	
Chestnut and Pea,	2208	
	4854	Per cent. shipped, 59
Dust in tons,	3336	" wasted, 41

6. *Shipped.*	*Tons.*	
Egg and Stove,	2214	
Chestnut and Pea,	1771	
	3985	Per cent. shipped, 58
Dust in tons,	2932	" wasted, 42

Mined.	*Shipped.*	*Dust.*	*Rock.*
5,100	2,613	2,547	157
10,709	5,713	4,977	247
7,462	4,584	3,278	149
6,910	4,104	2,938	141
8,029	4,854	3,336	200
7,053	3,985	2,932	159
45,263	25,853	20,008	1,053
	20,008		
	1,053		
	46,914		

46,914
45,263

1,751 tons, excess of actual product over supposed amount mined, as computed from mine cars, or 3½ per cent.

The total product of coal is 45,861 tons, of which 56.5 per cent. went into cars to be shipped to market, and 43.5 per cent. went to the waste heap.

The monthly wastage percentages varied thus: 42, 41, 42, 42, 47, 49; giving an average of 43.5 per cent. wastage, as above.

Colliery No. 28, Thomaston.

This colliery works the Holmes coal bed, 10 feet thick, and also the Mammoth coal bed, in three benches, the upper bench 12 feet, the middle bench 4 feet, and the lower bench 7 feet thick. There is also a new opening to a bed below.

The slope is 48° dip, but the workings of part of the colliery are flat.

The records of the breaker show thus:

1. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2165	
Egg and Stove,	3769	
Chestnut and Pea,	2473	
	8407	Per cent. shipped, 49
Dust in tons,	8567	" wasted, 51

2. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	3256	
Egg and Stove,	3456	
Chestnut and Pea,	2576	
	9288	Per cent. shipped, 47
Dust in tons,	10,474	" wasted, 53

3. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2160	
Egg and Stove,	1874	
Chestnut and Pea,	1533	
	5567	Per cent. shipped, 52
Dust in tons,	5143	" wasted, 48

4. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	1836	
Egg and Stove,	1668	
Chestnut and Pea,	1474	
	4978	Per cent. shipped, 48
Dust in tons,	5094	" wasted, 52

5. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2722	
Egg and Stove,	2473	
Chestnut and Pea,	2073	
	7268	Per cent. shipped, 56
Dust in tons,	5804	" wasted, 44

6. *Shipped.*	*Tons.*	
Lump, S. Boat and Broken,	2392	
Egg and Stove,	1944	
Chestnut and Pea,	1760	
	6096	Per cent. shipped, 54
Dust in tons,	5093	" wasted, 46

Mined.	*Shipped.*	*Dust.*	*Rock.*
17,149	8,407	8,507	1,384
19,149	9,288	10,474	1,917
10,109	5,567	5,143	906
9,462	4,978	5,094	910
11,627	7,268	5,804	1,087
10,699	6,096	5,093	1,110
78,195	41,604	40,175	7,314
	40,175		
	7,314		
	89,093		
89,093			
78,195			
10,898 tons, excess of actual product over computed amount mined, taken from record of mine cars, or 13.9 per cent.			

The monthly excess varies thus: 15, 22, 16, 15, 13, 7; giving an average of about 14 per cent., as above.

The total amount of coal mined is 81,779 tons, of which 50.9 per cent. has gone into cars for shipment to market, and 49.1 per cent. has gone to waste.

The waste percentages by the month vary thus: 46, 44, 52, 48, 53, and 51, giving an average of about 50 per cent. of wastage, as above.

Colliery No. 29, Glendower.

This colliery works the Mammoth coal bed 12 feet thick. The coal bed dips 48.°

The breaker record shows as follows:

1. *Shipped.*	*Tons.*	
Broken,	1091	
Egg and Stove,	2365	
Chestnut and Pea,	1603	
	5059	Per cent. shipped, 55
Dust in tons,	4146	" wasted, 45

2.	*Shipped.*	*Tons.*	
	S. Boat and Broken,	470	
	Egg and Stove,	977	
	Chestnut and Pea,	740	
		2187	Per cent. shipped, 54
	Dust in tons,	1852	" wasted, 46

3.	*Shipped.*	*Tons.*	
	S. Boat and Broken,	648	
	Egg and Stove,	907	
	Chestnut and Pea,	718	
		2273	Per cent. shipped, 54
	Dust in tons,	1899	" wasted, 46

4.	*Shipped.*	*Tons.*	
	S. Boat and Broken,	880	
	Egg and Stove,	1344	
	Chestnut and Pea,	945	
		3169	Per cent. shipped, 52
	Dust in tons,	2915	" wasted, 48

5.	*Shipped.*	*Tons.*	
	S. Boat and Broken,	1161	
	Egg and Stove,	1566	
	Chestnut and Pea,	1247	
		3974	Per cent. shipped, 55
	Dust in tons,	3249	" wasted, 45

Mined.	*Shipped.*	*Dust.*	*Rock.*
9,887	5,059	4,146	1,195
5,113	2,187	1,852	543
4,668	2,273	1,899	408
7,341	3,169	2,915	634
9,001	3,974	3,249	795
36,010	16,662	14,061	3,575
	14,061		
	3,575		
	34,298		

36,010
34,298

1,712 tons, excess of computed output taken by mine cars, over the actual output as given by shipments, dust and rock.

The total production of coal was 30,723 tons, of which 54.3 per cent. went into cars for shipment to market and 45.7 per cent. come under the heading of waste.

The waste percentage by months ran thus: 45, 46, 46, 48, 45, or an average of about 4.6 per cent., as above.

2. Red and White ash and Red ash Coals.

Colliery No. 30, Otto.

This colliery works the top bench of the Mammoth, 8 feet thick and also the Primrose coal bed, 9 feet thick, or 17 feet in all. The coal dips 33.°

The breaker record shows as follows :

1.	*Shipped.*	*Tons.*	
	Egg and Stove,	4498	
	Chestnut and Pea,	2365	
		6863	Per cent. shipped, 60
	Dust in tons,	4635	" wasted, 40

2.	*Shipped.*	*Tons.*	
	Broken, Egg and Stove,	3056	
	Chestnut and Pea,	1361	
		4417	Per cent. shipped, 49
	Dust in tons,	4580	" wasted, 51

3.	*Shipped.*	*Tons.*	
	Broken, Egg and Stove,	3758	
	Chestnut and Pea,	2117	
		5875	Per cent. shipped, 50
	Dust in tons,	5935	" wasted, 50

4.	*Shipped.*	*Tons.*	
	Broken, Egg and Stove,	3931	
	Chestnut and Pea,	2403	
		6334	Per cent. shipped, 43
	Dust in tons,	8360	" wasted, 57

5.	*Shipped.*	*Tons.*	
	Broken, Egg and Stove,	4206	
	Chestnut and Pea,	2835	
		7041	Per cent. shipped, 46
	Dust in tons,	8336	" wasted, 54

6.	*Shipped.*	*Tons.*	
	Broken, Egg and Stove,	3720	
	Chestnut and Pea,	2376	
		6096	Per cent. shipped, 58
	Dust in tons,	4430	" wasted, 42

7.	*Shipped.*	*Tons.*	
	Broken, Egg and Stove,	2899	
	Chestnut and Pea,	1755	
		4654	Per cent. shipped, 60
	Dust in tons,	3085	" wasted, 40

8. *Shipped.*	*Tons.*	
Broken, Egg and Stove,	2446	
Chestnut and Pea,	1355	
	3801	Per cent. shipped, 57
Dust in tons,	2875	" wasted, 43

Mined.	*Shipped.*	*Dust.*	*Rock.*
11,458	6,863	4,635	1,570
7,918	4,417	4,580	1,748
9,682	5,872	5,935	2,256
12,314	6,334	8,360	3,456
13,289	7,041	8,336	3,639
10,818	6,096	4,430	2,859
8,903	4,654	3,085	2,250
7,340	3,801	2,875	2,691
81,722	45,095	42,236	20,467
	42,236		
	20,467		
	107,798		
107,798			
81,722			

26,076 tons, excess of product over the calculated yield by mine car record, or 31.9 per cent.

This excess percentage varies by months thus: 27, 12, 23, 43, 47, 45, 33, and 14; the average being about 31 per cent., as above.

The total yield of the mine in coal is 87,331 tons, of which 52 per cent. went to market and 48 per cent. to wastage.

The waste percentage varied by months thus: 43, 40, 42, 54, 57, 50, 51, 40: the average of these being about 48 per cent. wastage, as above.

The enormous variation in the waste percentage is very noticeable, varying from 40 as the minimum to 57 as the maximum.

Though a period of 8 months running was taken to secure an average and prevent the inaccuracy which comes from taking a short period, yet even 8 months in this case do not give a fair average. On reëxamining the breaker records and going back for a much longer period it is clear that the average shipments are about 58 per cent. and the wastage 42 per cent.

Of this total wastage, the breaking and screening make up between 20 and 25 per cent.; the latter figure being

probably nearer the correct figure. But this average is only approximated, and is not as if taken from running clean coal through the breaker.

Colliery No. 32, Phœnix Park No. 2.

This colliery works the Primrose coal bed, 9 feet thick. The bed dips 36°.

The breaker record shows as follows:

1.	*Shipped.*	*Tons.*	
	Egg and Stove,	1496	
	Chestnut and Pea,	799	
		2295	Per cent. shipped, 63
	Dust in tons,	1369	" wasted, 37
2.	*Shipped.*	*Tons.*	
	Egg and Stove,	1777	
	Chestnut and Pea,	1139	
		2916	Per cent. shipped, 63
	Dust in tons,	1692	" wasted, 37
3.	*Shipped.*	*Tons.*	
	Egg and Stove,	1377	
	Chestnut and Pea,	804	
		2181	Per cent. shipped, 65
	Dust in tons,	1188	" wasted, 35
4.	*Shipped.*	*Tons.*	
	Egg and Stove,	988	
	Chestnut and Pea,	610	
		1598	Per cent. shipped, 60
	Dust in tons,	1074	" wasted, 40
5.	*Shipped.*	*Tons.*	
	Egg and Stove,	1717	
	Chestnut and Pea,	1177	
		2894	Per cent. shipped, 62
	Dust in tons,	1758	" wasted, 38
6.	*Shipped.*	*Tons.*	
	Egg and Stove,	956	
	Chestnut and Pea,	469	
		1425	Per cent. shipped, 64
	Dust in tons,	794	" wasted, 36
7.	*Shipped.*	*Tons.*	
	Egg and Stove,	1657	
	Chestnut and Pea,	1323	
		2980	Per cent. shipped, 57
	Dust in tons,	2267	" wasted, 43

Mined.	*Shipped.*	*Dust.*	*Rock.*
4,099	2,295	1,369	640
5,056	2,916	1,692	738
3,800	2,181	1,181	541
3,025	1,598	1,074	456
4,961	2,894	1,758	684
2,211	1,425	794	296
5,536	2,980	2,267	673
28,688	16,289	10,135	4,028
	10,135		
	4,028		
	30,452		
30,452			
28,688			

1,764 tons, excess of actual product over the calculated product from mine car records, or 6.1 per cent.

This excess percentage varies monthly, thus; 6.9, 13.7, 7.5, 3.4, 2.7, 5.7, 4.9; the average being about 6 per cent., as above.

The total coal product amounted to 26,424 tons, of which 61.7 per cent. went to market, and 38.3 per cent. went to wastage.

The waste percentage varied by months, thus: 37, 37, 35, 40, 38, 36, 43; the average being about 38 per cent. of wastage, as above.

Of this total wastage probably between 20 and 25 per cent. are due to breaking and screening.

3. Lykens Valley Coal.

Colliery No. 32, West Brookside.

This colliery works the Lykens Valley coal bed, 9 feet thick, and dipping only 10.°

The breaker record shows thus:

1. *Shipped.*	*Tons.*	
* Lump, S. Boat and Broken, Egg and Stove, . . .	25,774	
Chestnut and Pea, ...	11,426	
	37,200	Per cent. shipped, 68
Dust in tons, ...	17,144	" wasted, 32

* As the Lump, Steamboat and Broken at West Brookside make only from 6 to 9 per cent. of the total shipments, they are included in these tables with the Egg and Stove.

2.	*Shipped.*	*Tons.*	
	Lump, S. Boat, Broken, Egg and Stove,	15,746	
	Chestnut and Pea,	6,658	
		22,404	Per cent. shipped, 69
	Dust in tons,	9,970	" wasted, 31

3.	*Shipped.*	*Tons.*	
	Lump, St. Boat, Broken, Egg and Stove,	17,977	
	Chestnut and Pea,	7,619	
		25,596	Per cent. shipped, 69
	Dust in tons,	11,723	" wasted, 31

4.	*Shipped.*	*Tons.*	
	Lump, S. Boat, Broken, Egg and Stove,	16,961	
	Chestnut and Pea,	6,863	
		23,824	Per cent. shipped, 68
	Dust in tons,	11,027	" wasted, 32

5.	*Shipped.*	*Tons.*	
	Lump, S. Boat, Broken, Egg and Stove,	21,610	
	Chestnut and Pea,	8,532	
		30,142	Per cent. shipped, 69
	Dust in tons,	13,387	" wasted, 31

6.	*Shipped.*	*Tons.*	
	Lump, S. Boat, Broken, Egg and Stove,	18,986	
	Chestnut and Pea,	7,484	
		26,470	Per cent. shipped, 68
	Dust in tons,	12,619	" wasted, 32

7.	*Shipped.*	*Tons.*	
	Lump, S. Boat, Broken, Egg and Stove,	13,483	
	Chestnut and Pea,	5,562	
		19,045	Per cent. shipped, 67
	Dust in tons,	9,174	" wasted, 33

8.	*Shipped.*	*Tons,*	
	Lump, S. Boat, Broken, Egg and Stove,	26,730	
	Chestnut and Pea,	10,103	
		36,833	Per cent. shipped, 70
	Dust in tons,	15,615	" wasted, 30

Mined.	*Shipped.*	*Dust.*
47,981	37,200	17,144
27,708	22,404	9,970
30,853	25,596	11,723
30,023	23,824	11,027
37,743	30,142	13,387
33,881	26,470	12,619
23,580	19,045	9,174
43,939	36,833	15,615
275,703	221,514	100,659
	100,659	
	322,173	
322,173		
275,108		

46,465 tons, excess of actual product over computed product, or 16.8 per cent. These excess percentages varied considerably by months, running thus: 13.2, 16.8, 20.9, 16, 15.3, 15.3, 19.6, 19.3, and averaging about 17 per cent., as above.

The total product was 322,173 tons, of which 68.8 per cent. went into the cars for shipment to market, and 31.2 per cent. went on to the dirt heap.

The percentages of waste by months ran thus: 32, 31, 31, 32, 31, 32, 33, 30; averaging 31.2 per cent., as above.

This average may be somewhat too low, but is not much away from the actual facts.

For the bed is nearly flat: it is clean coal; there is but little wasted in the mines; and the coal is not brittle and does not splinter up into buckwheat and dust. The actual breaker waste at the Lykens Valley collieries for breaking and screening is probably not over 21 per cent.

Colliery No. 33.

Mr. Holden Chester, the General Superintendent of the Lykens Valley Coal Company, gives the following statement as the average loss of the collieries under his charge.

"The loss in the amount taken out, especially in soft or free-burning coals, is about 38 per cent. One half, or 19 per cent., of this is made in the mine by the explosives used; the other half, or 19 per cent., is made in breaking and preparing the coal into domestic sizes.

This result can only be attained by the use of the best

machinery, which we too often neglect and allow to become dull, thus increasing the waste very much.

But we too often lose sight of the other half of the waste brought from the mines, principally the fruits of injudicious use of the explosives by incompetent miners; and especially is this the case in the soft or free-burning anthracite coals."

Chapter VII.

Waste in Breaking Anthracite Coal Continued.—Lehigh, Wyoming, and Lackawanna Basins.

In the Lehigh region the dust is usually washed from the breaker, and it is difficult therefore to secure reliable figures of breaker waste.

Mr. Thos. S. McNair, of the Lehigh Valley Railroad Company, furnishes the following results of some observations made by him for this report.

The following is the breaker waste at four collieries in this region:

	Dust, p. c.
1. Mt. Pleasant colliery; working about 50 per cent. each of the Mammoth (E) and Wharton (D) coal beds,	$13\frac{5}{10}$
2. Hazelton, No. 6, colliery; working the Mammoth coal bed,	$12\frac{5}{10}$
3. Hollywood colliery; working the Mammoth coal bed,	$14\frac{46}{100}$
4. Harleigh colliery; working about 45 per cent. of the Wharton (D) and 55 per cent. of the Mammoth (E) coal beds,	$8\frac{35}{100}$

At the above collieries all stuff not large enough to pass over a $\frac{5}{16}''$ mesh of the revolving screen went out as "dirt."

The result at Harleigh is not so exact as at the other three collieries, as the experiment for dirt was but of one trial, and then only for a short time, a few hours.

At the other three the dirt was hauled out in cars, and the result is of a series of observations taken. At Harleigh the dirt is carried away by the water used in washing, and had to be specially caught.

The fine slate picked and jigged out at the same experiment was—

	Per cent.
Harleigh (many experiments,)	$7\frac{45}{100}$
Mt. Pleasant,	$8\frac{5}{10}$
Hazleton, No. 6,	$4\frac{43}{100}$
Holleywood,	$9\frac{86}{100}$

All of these percentages by measurement.

Gen. Lilly, at Jeddo Colliery, works the Mammoth 30 feet thick.

He says that he gets out two thirds of the coal and leaves one third in the mine.

Dr. Wentz, at Eckley, works the Buck Mountain 12 feet thick.

He says that he gets 80 per cent out and leaves 20 per cent. in the mine.

Mr. Daniel Bertsch of the Upper Lehigh Coal Company says:

The average thickness of our Buck Mountain vein is 12 feet; pitch on north side, 36°, and on south side of basin, 12;° 80 per cent. of the coal brought out of the mine; waste in preparing about 11 per cent. of dust and 6 per cent. of slate, a total of 17 per cent.

The collieries selected to secure statistics of the wastage in breaking and screening coal in the Wyoming and Lackawanna coal basins work the Baltimore vein chiefly though there are also figures showing breaker waste in coal from the Hillman vein, the Ross vein, and the Red Ash vein.

The figures vary greatly and show how differently the different coal beds are splintered by the breaker.

Prospect Colliery.

This colliery, only one mile from Wilkes-Barre, works the Baltimore coal bed of the Wyoming Valley.

The coal is in two benches, sometimes worked together, but usually separated, and yields in all some 15 feet of coal. The dip of the coal bed is gentle.

A cubic foot of the coal dust and coal was taken direct from the shutes at the colliery and carefully weighed with the following results:

Dust, with much buckwheat coal, (perhaps one half small coal,)	56 lbs.
Pea,	55½ "
Chestnut,	53½ "
Stove,	50½ "

A careful record was kept at the breaker to determine the waste in dust. Leaving out all the slate, the weight of the dust was ascertained by itself to compare with the shipped coal.

The Baltimore vein at this colliery is nearly horizontal and some 10 to 12 feet thick. There is, therefore, little dust made in the mine, except that inevitably caused by blasting. The shipments were of the following sizes:

Lump,	390
Broken,	565
Egg,	1,629
Stove,	4,670
Chestnut,	3,766
Pea,	533
	11,553 tons.

In shipping this amount of coal, there were hauled from the breaker 3,150 tons of dust, giving therefore:

Coal,	11,553 tons or 78.6 per cent.
Dust,	3,150 tons or 21.4 per cent.

Of this, 21.4 per cent. of dust, probably the proper subdivision, is

Breaker waste,	11
Screen waste,	4
Mine waste,	6.4
	21.4

This average will apply to the collieries working the Baltimore vein in the Wyoming valley.

The proportion of wastage of refuse (slate, bone coal, and dust) as compared to total mine product, was not determined.

Mr. Joseph S. Harris, Chief Engineer of the Lehigh and Wilkes-Barre Coal Company, furnishes the following results, showing the actual breaker waste at the collieries of the company in the Wyoming valley. They show at the same time the saving effected by improved apparatus.

Test and Comparison of Old and New Style Rolls in L. and W. B. Coal Co.'s Breakers, Wyoming Division.

1. Diamond Breaker, February 2, 1880.
Baltimore vein.
Improved Standard Steel Tooth Crushers.

SIZE OF COAL.		MESH.		Lbs.	Per cent.
No.	Name.	Over.	Thro.'		
1.	Broken,	$2\frac{3}{4}$	Rolls,	4,705	42.01
2.	Egg,	$2\frac{1}{4}$	$2\frac{3}{4}$	1,693	15.12
3.	Stove,	$1\frac{1}{4}$, $1\frac{3}{8}$	$2\frac{1}{4}$	1,010	9.01
4.	Small stove,	$1\frac{1}{4}$, $1\frac{1}{8}$	$2\frac{1}{4}$	1,006	8.98
5.	Chestnut,	$\frac{5}{8}$	$1\frac{1}{4}$	958	8.79
6.	Pea,	$\frac{1}{2}$ and $\frac{3}{8}$	$\frac{5}{8}$	471	4.71
	Dirt,	....	$\frac{3}{8}-\frac{1}{2}$	1,233	11.01
	Loss,	....	....	97	0.87
	Total,	....	....	11,173	

Total loss, 11.88 per cent.

2. Empire Breaker, February 2, 1880.
Baltimore vein.

OLD STYLE CRUSHERS.						NEW STYLE CRUSHERS.	
SIZE OF COAL.		MESH.		Lbs.	Per cent.	Lbs.	Per cent.
No.	Name.	Over.	Thro'.				
1	Broken,	$2\frac{3}{4}$	....	706	31.57	1,086	48.47
2	Egg,	$2\frac{1}{4}$	$2\frac{3}{4}$	451	20.04	271	12.13
3 & 4	Stove,	$1\frac{1}{4}$, $1\frac{3}{8}$	$2\frac{1}{4}$	122	15.76		
4	Small stove,	$1\frac{1}{4}$, $1\frac{3}{8}$	....	231		703	31.38
5	Chestnut,	$\frac{5}{8}$	$1\frac{1}{4}$	256	11.43		
6	Pea,	$\frac{1}{2}-\frac{3}{8}$	$\frac{5}{8}$	207	9.24		
	Dirt,	....	$\frac{3}{8}-\frac{1}{2}$	213	11.96	180	8.03
	Loss,	....	....	54			
	Total,	....	....	2,240	....	2,240	

Total loss, 11.96 per cent. Total loss, 8.03 per cent.

3. Empire Breaker, February 2, 1880.
Hillman Vein.

Old Style Crushers.						New Style Crushers.	
Size of Coal.		Mesh.		Lbs.	Per ct.	Lbs.	Per ct.
No.	Name.	Over.	Thro'.				
1	Broken,	2¾		756	33.75	920	41.08
2	Egg,	2¼	2¾	385	17.90	336	15.00
3 & 4	Stove and Small S.,	1¼, 1⅝	2¼	298	13.30	716	31.96
5	Chestnut,		1¼	242	10.80		
6	Pea,	½—⅝		163	7.28		
	Dirt,		⅜—½	314	17.68	268	11.96
	Loss,			82			
	Total,			2240		2240	

Total loss, 17.68 per cent. Total loss, 11.96 per cent.

4. Ashley No. 6 Breaker.

Baltimore Vein.						Ross Vein.		Red Ash Vein.	
Size of Coal.		Mesh.		Lbs.	Per ct.	Lbs.	Per ct.	Lbs.	Per ct.
No.	Name.	Over.	Thro'.						
1	Broken,	2¾		1100	49.11	1050	46.88	1093	48.78
2	Egg,	2¼	2¾	240	10.72	252	11.18	350	15.62
3	Stove,	1¼, 1⅝	2¼	408	18.21	475	21.21	405	18.07
5	Chestnut,		1¼	233	10.40	217	9.69	261	11.65
6	Pea,	½, ⅝							
	Dirt,		⅜—½	259	11.56	246	10.99	131	5.88
	Total,			2240		2240		2240	

Total loss, 11.56 per cent. Loss, 10.99 per cent. Loss, 5.88 per cent.

5. Sugar Notch No. 10 Breaker, January 1, 1880.

OLD STYLE ROLLS.						NEW ROLLS.		
SIZE OF COAL.		MESH.		Lbs.	Per ct.			
No.	Name.	Over.	Thro'.			No.	Lbs.	Per ct.
1	Broken,	2 3/4	. .	662	33.10	1	884	44.26
2	Egg,	2 1/4	2 3/4	398	19.90	2	283	14.15
3	Stove,	1 1/4, 1 3/8	2 1/4	262	13.10	3	213	10.65
4	Small stove,	1 3/8	2 1/4			4	85	04.25
5	Chestnut,		1 3/8	166	8.30	5	174	08.70
6	Pea,	1/2, 5/8	3/8	137	6.85	6	98	04.90
	Dirt,	.	3/8, 1/2	375	18.75	Dirt.	263	13.15
	Total,	. . .	. . .	2000	. . . .	. . .	2000	

662 pounds broken coal put through the Pony rolls made: Coal, 555 pounds=83.83 per cent.; dirt, 107 pounds=16.17 per cent.

884 pounds No. 1 coal put through Pony rolls make prepared sizes: Coal, 768 pounds = 86.88 per cent.; dirt, 116 pounds=13.12 per cent.

6. Lance No. 11 Breaker, January 29, 1880. Old style crushers, prepared rolls.

SIZE OF COAL.		MESH.		Lbs.	Per cent.
No.	Name.	Over.	Thro'.		
1	Broken,	2 3/4	. .	650	29 2/112
2	Egg,	2 1/4	2 3/4	386	17 6/112
3	Stove,	1 1/4, 1 3/8	2 1/4	471	21 8/112
4	Small stove,	1 3/8	2 1/4		
5	Chestnut,		1 3/8	164	7 36/112
6	Pea,	1/2, 5/8		215	9 87/112
	Dirt,	. . .	1/2, 5/8	354	15 70/112
	Total,	. . . .	. . . .	2240	

7. Nottingham No. 15, January 29, 1880.
Old style crushers, steel tooth prepared, old style rolls.

No.	Size of Coal. Name.	Mesh. Over.	Through.	Lbs.	Per cent.
1	Broken,	2¾	. . .	924	41 28/112
2	Egg,	2¼	2¾	239	10 7/112
3	Stove,	1¼, 1⅜	2¼	239	10 7/112
4	Small stove,	1⅜	2¼	165	7 4/112
5	Chestnut,	⅝	1¼	250	11 14/112
6	Pea,	½, ⅜	⅝	147	6 6/112
	Dirt,	. . . .	½, ⅜	276	12 3/112
	Total,	. . . .	. . . . .	2240	

8. Reynolds No. 16 Breaker, January 29, 1880.
No Crushers.
Old Style Prepared Rolls.

No.	Size of Coal. Name.	Mesh. Over.	Thro.'	Lbs.	Per ct.
1	Broken,	2¾	. . .	557	24 9/112
2	Egg,	2¼	2¾	423	18 9/112
3	Stove,	1¼, 1⅜	2¼	212	9 5/112
4	Small stove,	1¼, 1⅜	2¼	216	9 7/112
5	Chestnut,	⅝	1¼	224	10
6	Pea,	½—⅜	⅝	216	9 7/112
	Dirt,	. . . .	½—⅜	392	17 6/112
	. . . . .	. . . .	. . . .	2240	

These tables give some very interesting figures.

With old style crushers the actual breaker waste ranges from 12 to nearly 19 per cent. Working the Baltimore vein, the new style apparatus reduces the this loss by some 5 per cent.

As illustrating the importance of the physical structure of the coal in relation to breaker waste, it will be noted that the Red Ash vein of the Ackley No. 6, breaker loses only 5.88 per cent., while the Baltimore vein, at the same colliery, loses 11.56 per cent., or nearly double.

It would be hardly in order to call the breaker a very murderous invention where it was losing only 5.88 per cent. of the coal fed into it. It could not be broken by hand in a coal cellar for less than that percentage of loss.

With reference to wastage in the Lackawanna region, Mr. Snyder, Chief Engineer of the Delaware, Lackawanna, and Western coal mines, furnished the following as an estimate of the average waste at the company's collieries. He says:

"The pitch in the middle portion of the main basin will average about 5 degrees; at the out-crops it varies from 20 to 50 degrees in the Lackawanna region.

In the Wyoming region the pitches are sharper.

In the Lackawanna basin all the veins above the big or "G" vein have slate roof and floor. The big or "G" vein roof is rock and slate in alternate layers; the floor fire-clay and slate mixed.

The Clark or "H" vein, the next below the big vein, has slate roof and hard rock floor.

Under the present system of mining *about 15 per cent. is left in pillars.*

In preparing the coal for market about (*30*) *thirty per cent. is sent to the culm pile.*

The percentage of waste varies with different veins, and with different portions of the same vein; the above estimate is a general average of the waste, taking all the mines of the D. L. and W. Company.

As to any change of plan in the mining with a view to the saving of pillars, that are unavoidably left or lost under the present system, in our judgment there can be no specific plan of mining adopted that would be applicable to all the veins in any part of the anthracite regions. Any plan would have to be modified to suit each particular case of fault or local disturbance.

As to the waste in the preparation of coal for market, its material reduction below the present percentage is a problem yet to be solved, unless it all goes as lump, and the consumer will consent to go back to the good old days when the present smashing system was unknown, and the head

of the family, or one of his worthy descendants, developed his muscle with pick and hammer in the coal shed."

The Delaware and Hudson Company have mines northeast of Scranton where the coal is lying almost horizontal in the center of the Lackawanna region.

The coal worked by them is about 8 feet in thickness, or possibly somewhat more. Working a bed of this size, and with flat workings, their mine car comes out with nothing in it but coal, the refuse being easily selected in the mine.

The Superintendent, Mr. Vandling, states that their "mine ton" is 2700 pounds, and this amount charged into the breaker yields a full ton of 2240 pounds for shipment to market.

This makes only 17 per cent. of breaker waste in all.

Now some of this waste must be made in mining and be in the mine car when it goes to the breaker; but it must be a very small amount of dust, and probably it would be safe to sub-divide this 17 per cent. into

Breaker waste,	14 per cent.
Mine waste,	3 per cent.
	17 per cent.

INDEX TO A².

SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA.

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WM. A. INGHAM,
Secretary of Board.

Rooms of Commission and Museum:
223 Market Street, Harrisburg.

Address of Secretary:
223 Market Street, Harrisburg.

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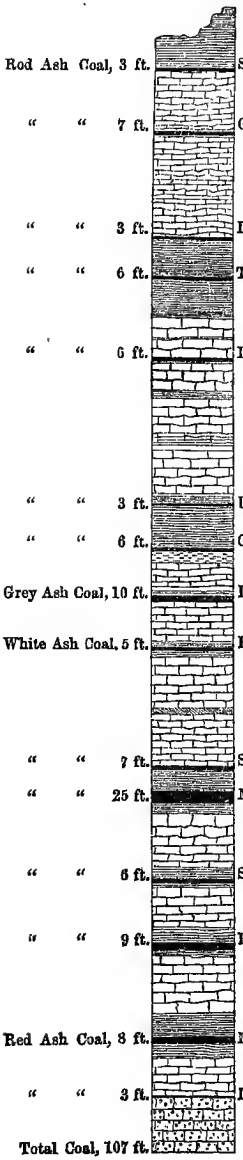
Cross Section in the Southern Anthracite Coal Field of Pa.



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